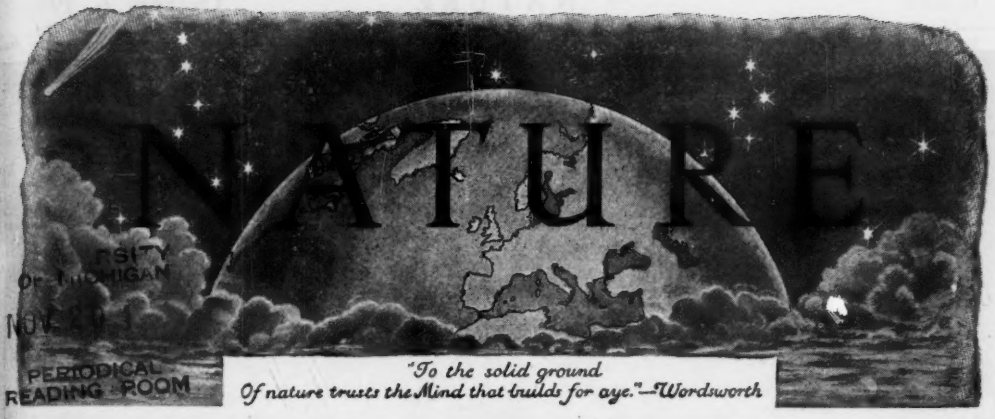

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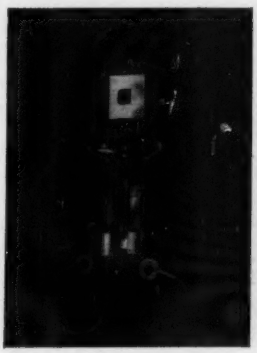

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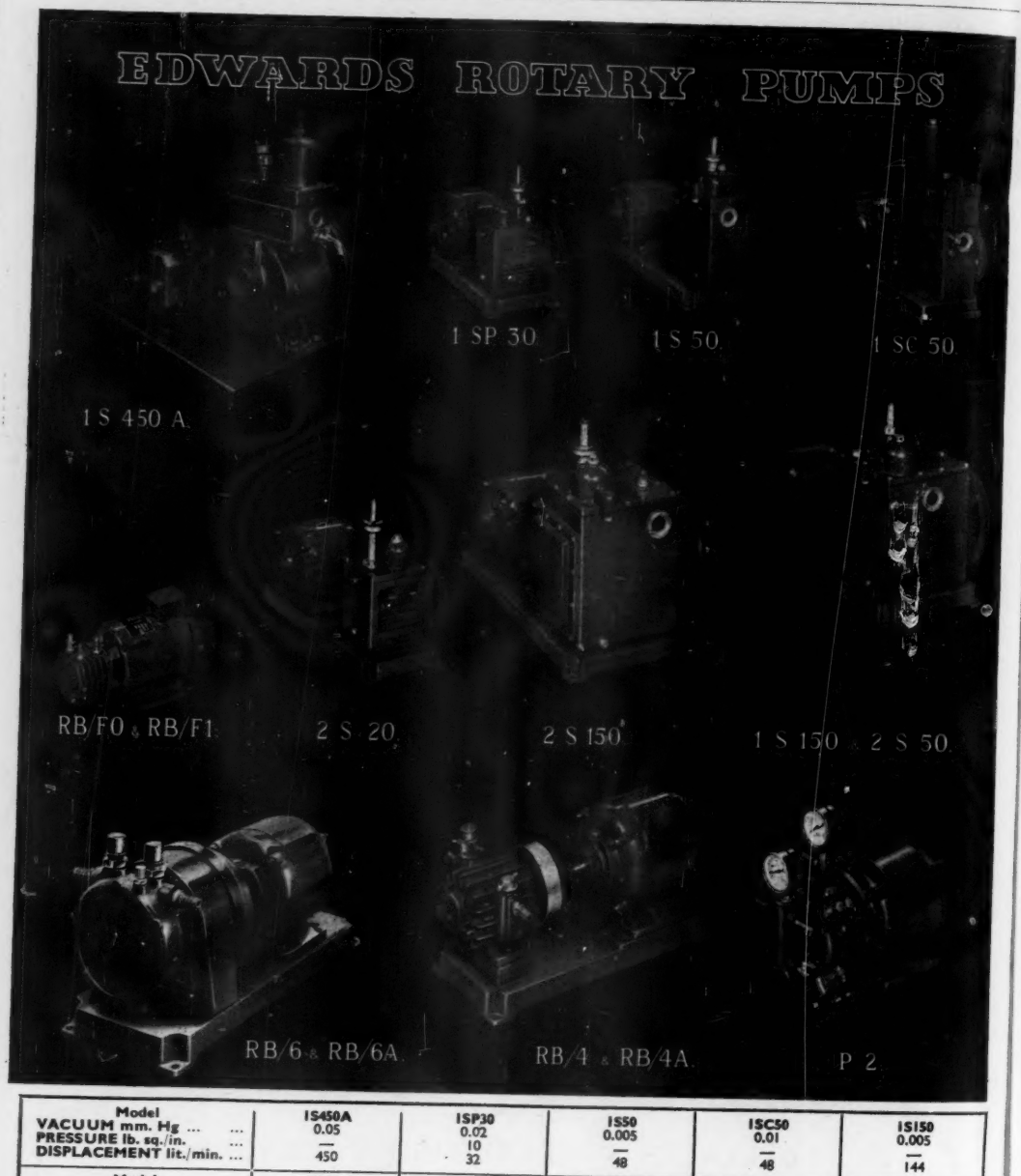

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LEADERSHIP IN THE MODERN STATE

ON at least three occasions in recent months, Government action in Britain has raised the question of the appropriateness of our existing organization of central government. The establishment of the Ministry of Local Government and Planning, with the re-distribution of functions between the new Ministry and the Ministry of Health, raised fundamental issues that did not receive adequate discussion at the time. Similar issues were involved in the subsequent creation of the Ministry of Materials, while the question of the means of control of the nationalized industries is perpetually being raised, sometimes on Government initiative, sometimes by critics of Government policy. Particular and more limited aspects of the general question have also been discussed from time to time as, for example, in a debate in the House of Lords on the most appropriate means for administering the atomic energy project, and in comments in reports of the Select Committee on Estimates on Treasury control.

Full discussion, free from political bias, of the principles involved is of the first importance. It is the great merit of such lectures as the Romanes Lecture on "The Science and Art of Government" which Lord Hankey delivered at Oxford on June 7, and which has now been published*, that they enable us to judge the soundness of decisions or proposals in the light of rules or principles of statecraft which are frequently forgotten in the press of business. Lord Hankey postulated, as the main objects of government, peace abroad and contentment at home without too much encroachment on liberty; and in pursuance of the first, which to-day is more important than ever, he discussed at some length the reasons for the failure of the Allied Governments to achieve that first object of victory, and the obstacles to their success.

Even here, however, when Lord Hankey traces the real weakness of the United Nations to the fact that it is required to combine the roles of arbiter and belligerent, and thus to become judge in its own cause, his observations have a profound significance for much that is happening in our domestic affairs to-day, and indicate the roots of difficulties there also. Permanent peace cannot be compelled by force, and the important work of the United Nations in the economic, social, cultural and spiritual fields requires supporting by some great and sustained spiritual initiative. Nor has fortune favoured the realization of the second object, "contentment at home without too much encroachment on liberty"; and in considering what could be done to increase contentment Lord Hankey turned largely to the political maxims of the Greeks. First of these, he commends that of avoiding extremes, and refers to criticism of post-war governments of Britain for driving political theories like nationalization to extremes and for wasting public money on untested

* The Science and Art of Government. By the Rt. Hon. Lord Hankey. (The Romanes Lecture delivered in the Sheldonian Theatre, 7 June 1951.) Pp. 34. (Oxford: Clarendon Press; London: Oxford University Press, 1951.) 3s. 6d. net.

schemes of Colonial development. The latter lesson would appear to have been learned at last but at great cost, and it is further emphasized in a passage in the last report from the Advisory Council on Scientific Policy.

As regards nationalization, less confidence can be felt, particularly in view of statements about the engineering and the chemical industries. Here, as Lord Hankey proceeds to show, the maxim attributed to Pittacus of Mytilene, "Know thy opportunity", is equally pertinent. He raises the question whether advantages could not have been won from the austerities of to-day by concentrating on overdue reforms that will increase our strength without making demands on financial or other resources needed for rearmament. The timing of action is indeed the key to success, and although Lord Hankey does not discuss particular instances of bad timing that have been responsible for our present difficulties, he makes one important suggestion. It is not nationalization alone, carried out with insufficient regard to the administrative and other resources available for implementing a policy, and too much in subservience to a political doctrine, that is responsible for the strain of overwork on ministers, Parliament and public servants and is already endangering the country's constitution, for all its strength. Lord Hankey rightly observes that the burden of government has been enormously increased by the new and sometimes unnecessary functions imposed by the work of the United Nations and its satellite bodies, the Atlantic Treaty Organization and other developments. This in itself has led to proliferation of commissions, boards, councils and committees at least as much as internal policy. When Lord Hankey's comment is endorsed by the dignified warning about overstrain and illness contained in a note "The Price of Administration", commenting in a recent issue of the *Journal of Public Administration* on the tragic and premature death of Sir Arthur Street, and this is accompanied by the loss of senior Civil Servants from Whitehall to industry, the situation is clearly serious. We are in truth desperately short of experienced administrators in the service of the State, and some of the superhuman load of administrative responsibility must be taken off the shoulders that now bear it.

Something might perhaps be done to check the tendency by making the upper ranks of the Civil Service less financially disparate with those of industry. But a drastic and immediate overhaul of the whole task of administration is desirable, and might also offer surprising economies. Besides avoiding the initiation of measures for the implementation of which trained and experienced staff is not available, it is imperative that there should be a rigorous pruning of all the petty controls and responsibilities which cannot be clearly shown to be necessary in the public interest. Not the least is this necessary in those departments such as the Board of Trade, which, already structurally weak and carrying an absurd load of duties, has recently lost its permanent secretary, Sir John Woods, who has gone to the English Electric Co. There is little hope of rapidly increasing the number of trained senior Civil Servants, and practically the only hope of relief is to prune, wherever possible, the activities of Government.

Lord Hankey made a second practical suggestion—that the whole population should be instructed how to obtain adequate nutrition from austerity rations, by correctly balancing proteins, carbohydrates, fats, vitamins and mineral salts and by other measures which would greatly improve national health, avoid dental decay and effect important economies. Science, as he points out, has already given the lead here, and to achieve success the wholehearted co-operation of the medical profession, nurses and scientific workers from many fields would be required. It is a matter involving not the expenditure of great sums on nutrition but a great deal of education, and here the wider connotation of Lord Hankey's suggestion is important.

Nearly fifty years ago, in the last speech of his South African tour, Mr. Joseph Chamberlain observed: "Everything depends, in administration and in high politics, upon the extent to which those who govern and those who are governed are able, to some extent at any rate, to put themselves in each other's places". Failure to do so, to observe what is from one point of view in national affairs the Solon maxim, "Know thyself", has been a main cause of many difficulties in which Great Britain now finds itself. With it, however, has gone disregard of the maxim of Thales—"Suretyship is the forerunner of ruin"; and there is no more searching passage in Lord Hankey's lecture than that in which he shows how neglect of this precept is inherent in the conception of the Welfare State and, if not watched, can bring all to ruin.

Lord Hankey concludes that while there is no ground for complacency, until rearmament has made further progress, there is no reason for pessimism. Nevertheless, we must avoid waste and dissipation of our scientific and other resources. With that latter problem Lord Hankey was concerned more particularly in a subsequent lecture on technical and scientific man-power given on August 29. This lecture was the fourth in a series of Centenary Lectures on "The Worker in Industry", arranged by the Ministry of Labour and National Service (now issued by the Ministry), and in it Lord Hankey referred to the large groups of workers in science and technology, grouped sometimes by professions, sometimes geographically, sometimes in government service, sometimes in private industry or groups of industries, whose higher direction and co-ordination call for a special type of scientific and technological administrator who is not easy to find. There is in science and technology, he said, the same need as in the Services for a cadre of persons qualified for such directorate and co-ordinating responsibilities at the highest level.

It is suggested by Lord Hankey that aspirants to such posts should have some establishment comparable to the Imperial Staff College, where they would gain a more intimate knowledge of sciences and technologies other than their own, and would meet people with totally different experience in various branches of government and administration, finance, economics, humanities and international

affairs. This appears to be advocating a scientific and technological staff college on the model of the Imperial Defence College. It was never the intention, however, that scientific men and technologists with administrative gifts and destined for administrative responsibilities should be excluded from the Administrative Staff College already established at Henley. In such a college they would assuredly more readily correct the deficiencies of specialization and broaden their outlook than in a separate scientific staff college, and in doing so would help to diffuse a much-needed understanding of science into government, the humanities and other spheres of national life.

It will not, of course, be easy as yet to find scientific men and technologists with the general knowledge and administrative ability required to organize and lead the mixed teams of large-scale scientific and industrial enterprise. Measures of reform in secondary as well as in scientific and technological education are necessary, as well as a greater readiness in government and in industrial circles to admit to administrative responsibility the scientific worker or technologist who shows evidence of such gifts. It may even be necessary to encourage him to use them; but although the men with whom we are here concerned will always be relatively few, there must be no attempt to increase the number of administrative positions. That must always be kept at the minimum consistent with efficiency: the present proliferation, as Lord Hankey remarked in his Romanes Lecture, is partly a consequence of so overburdening our administrators that they are unable to cope with the perennial task of reviewing organization.

In his later lecture, Lord Hankey touched on a question of government that is to some extent new, though of growing importance. Government, he emphasized, is concerned primarily with human beings, and accordingly human relations and human personality are dominating considerations. That applies equally to the question of technical and scientific man-power: without a large and adequate number of human beings highly trained for research, development and manufacture, science would decline, progress would be arrested and degeneracy result. In his Romanes Lecture, however, Lord Hankey's major concern appeared to be lest in the Welfare State we should sap, especially in the young, the sterling qualities which have made Britain great. Disaster could easily follow a policy of safety first, a decline in the spirit of public service or of adventure. In industry, as well as in maritime life, enterprise, a readiness to accept responsibility and run risks and to make ventures are as essential as in science or any other creative activity. There are elements in our society to day which threaten this spirit and discourage the adventurous, and of these Lord Beveridge gave plain warning in presenting his reports on 'social insurance' and on 'voluntary action'. It should be a first canon of statesmanship to avoid all measures which threaten the growing-points of science, art or industry, and to encourage as far as administrative action can the individuality and the spirit of enterprise which are the roots of national greatness.

Misgivings on this score are the real reason for the concern manifested, for example, in the House of Lords debate on the administration of the atomic energy project. It is vital to the future of Great Britain that conditions of service should be such as to attract the right type of men and women into the scientific and technological departments of the State, and encourage their most fruitful and creative use. Even now, despite the observations of the Barlow Report on scientific staff and the comments of the Select Committee on Estimates in 1947, the position is not entirely satisfactory. The right use of the scientific and technical expert and the proper relation between science and technology demand more attention than might appear from Lord Hankey's lecture; but none the less he indicates the principles which should determine that use and relation. Equally, his principles might be applied to the consideration of the measures affecting the organization of government and its efficiency. Treasury control of expenditure, although necessary to avoid waste, is a relatively minor matter. Suggestions of the Committee on Public Accounts for strengthening that control, including the appointment of Treasury nominees on semi-independent bodies financed from public funds, and for defining and strengthening the link between the departmental accounting officers and the Treasury, while valuable in themselves, become trivial unless the general policy of the central government is encouraging the initiative and enterprise on which Lord Hankey lays such stress.

That much is strongly contended, for example, in a recent memorandum from the Federation of British Industries, and apart altogether from party politics there is reason for doubting whether the whole basis of taxation policy is now in keeping with the country's long-term interests, and the need for encouraging research and development. An impartial examination of this issue is the more desirable since the ability of the private trust or corporation, such as the Nuffield Foundation, to continue to sustain the growing-points of science by voluntary effort is in doubt. Furthermore, the work of government rests to a large extent not only on the Civil Service but also on the services of an immense number of voluntary workers, in borough councils and magistrates' courts, hospital management committees, governing bodies of schools, and the like. Without this voluntary service the task of government, particularly of local government, could not be carried on. Quite apart from the continuance of that spirit of public service to which Lord Hankey referred, it is important that men and women of the right type should be forthcoming for such work in sufficient numbers. There are changes in social and economic conditions which are tending to check the supply, and on that ground alone an early review of local government is desirable. But Lord Hankey's lecture indicates clearly that the first need is some clear thinking on the whole field of central and local government organization, and an honest attempt to apply firmly and courageously the principles the soundness of which has been attested by more than two thousand years of human experience.

FORECASTING THE WEATHER

Neue Methoden der Wetteranalyse und Wetterprognose

Von Dr. Richard Scherhag. Pp. xii+424. (Berlin, Göttingen und Heidelberg: Springer-Verlag, 1948.) 78 D. marks.

WITHIN the past twenty years the forecasting of to-morrow's weather has become a much more formidable task than it was in earlier years. This comes about not so much because more precision is expected, but because the forecaster is now required to analyse so many more reports and to apply so much recently acquired knowledge of the atmosphere before he can make a satisfactory assessment of the probabilities. Even then he can seldom do justice to his forecast, because of limitations of newspaper space and broadcasting time; but that is another matter.

Until the 1930's, the surface weather chart with its sea-level isobars was the forecaster's main tool; with it he achieved a measure of success which in retrospect is surprising. He always knew that there must be close links between the behaviour of the low- and high-pressure patterns on his surface charts and what was going on in the free atmosphere; but he had not enough information to study the mechanism. Then the application of radio and radar to the measurement of the meteorological elements in the atmosphere and improvement in the means of collecting reports from wide areas provided the forecaster with what he needed; but the new flood of information also brought new problems, not the least of which was the devising of practical and speedy means of analysing and assessing the great mass of surface and upper-air observations which poured on to his bench from the greater part of the hemisphere several times a day.

It is mainly with this problem, and with the summarizing of his long experience in applying upper-air analysis to day-to-day forecasting in Germany, that Dr. R. Scherhag's treatise is concerned, and its importance lies in the fact that it is written from the point of view of the practising forecaster. So many books have been written on meteorological theory and so few by experienced forecasters for forecasters. Dr. Scherhag has divided his book into five major parts dealing respectively with (1) the bases of synoptic meteorology, (2) the climatology of the upper atmosphere and its relation with weather, (3) three-dimensional analyses of weather situations, (4) forecasting procedure in Germany, and (5) long-period forecasting. The second, third and fourth parts are particularly valuable, not for any novel ideas they contain—the techniques described have already been adopted or developed and extended independently in other weather services—but for the emphasis on daily forecasting practice.

In Germany the procedure is to prepare contour charts for isobaric surfaces at five levels up to 41 millibars (70,000 ft.) for the standard times of observation each day. After assessing the changes in thickness of the layers between these surfaces which are likely to be brought about by horizontal and vertical movement and by radiation, the future deformations and positions of the upper isobaric surfaces are estimated, taking into account the probable disposition of the pressure patterns on the surface chart in order to keep the whole system mutually consistent. This is the framework which has then to be filled in with considerations of the changing characteristics, history, and movement of the air masses taking part, and of the regions of interaction between these masses, so leading finally to a forecast of the weather over a particular region at a particular time.

Most modern weather services now follow a similar procedure; but as the physics of no single stage is completely understood, either in Germany or elsewhere, varying degrees of empirical treatment necessarily enter, with emphasis on factors which differ from one country to another. To Dr. Scherhag the day-to-day changes in the stratosphere have important interrelations with weather: in some circumstances he may even select the regime at the 41-millibar level as giving the best guide to the future movements of the pressure field lower down. Without denying that the stratosphere may play an important part, forecasters in other services look to lower levels for the dominating factors, and instead of extending their analysis ever higher, as Germany's recent isolation seems to have driven Dr. Scherhag and his colleagues to do, they pay more attention to the hemispherical circulation pattern in the lower half of the atmosphere.

Almost all Dr. Scherhag's 400-page treatise is concerned with forecasting for periods up to 40 hours ahead, and the brief section of 15 pages on long-range forecasting is not encouraging. The author sees little prospect of extending modern synoptic procedures beyond three days, and though other methods, such as the study of weather singularities and periodicities and pressure waves, and the effects of sunspots and volcanic dust, may have their applications, Dr. Scherhag cannot yet foresee any technique for making useful forecasts for longer periods as a regular procedure.

The book is excellently illustrated with more than two hundred diagrams, and has a bibliography of nine hundred items. Dr. Scherhag and his publishers are to be congratulated on making a contribution of first class importance to the literature of weather forecasting.

J. M. Stagg

UNITY AMID COMPLEXITY

Aspects of Form

A Symposium on Form in Nature and Art. Edited by Lancelot Law Whyte. Pp. ix+249 (32 plates). (London: Percy Lund, Humphries and Co., Ltd., 1951.) 21*s*. net.

THIS is one of the most intriguing books of recent times. It is also one of the most symptomatic. A stage has clearly been reached when thinkers of several kinds, namely, physicists, biologists, psychologists and art-historians, have cast professional discretion aside, and asked what form is, and what—if anything—we know about it. The result is a symposium at once original and, in the best sense, speculative. The discussion hinges upon "the unity of spatial form in relation to complex processes". This cardinal concept is allowed to develop in an almost classical environment, while the details emerge in the modern synthetic manner. (It is as if, writing *S* for spatial form and *C* for complex process, one was invited to put *SRC* and to let the whole subject take shape within the calculus of relations.)

In particular, a crystallographer leads off by showing how visual configuration passes through 'occupation' and finishes with abstract organization. This, of course, is but one way of saying that material objects tend to obey the law of *prägnanz*, as in *Gestalt* theory. It is also a species of homopolar bond with Dr. Arnheim's paper later on, concerning artistic form. Meanwhile, an astronomer contributes a chapter full of interesting twentieth-century views upon that typically Greek theme, permanence *versus* change. Next come a couple of distinguished biological essays, and then one by Dr. H. B. Cott (of camouflage fame) dealing with the appearance of animals, this implying the existence of vision. The subtle point here is the over-riding influence of contrast, itself a variety of form. Later chapters describe brain patterns, and the functional substitute. The editor (Mr. L. L. Whyte) himself concludes with a chronology of form, and a bibliography.

Slight in bulk, this volume yet represents a prodigious effort, the magnitude of which the reader may not realize until he reaches the last few pages. Then he may discern something of the cost, in the hard labour of thought, which the composition and illustrations must have involved. Seldom can the yield have been more worth while. This said, it may not be too graceless to remark upon a few obvious omissions from the book-list; for example, Speiser's profound "Mathematische Denkweise", Beilby's "Aggregation and Flow of Solids", and E. S. Russell's "Directiveness of Organic Activities", all immediately concerned with the growth of pattern. Incidentally, Koehler's book (p. 246) deals with a multitude of facts, and its title needs an 's' accordingly. Naturally, it is fully recognized that the present volume has been produced in connexion with an exhibition of contemporary art, and that therefore its bias (in so far that it has one) is in that direction.

Nevertheless, there is at least an equal need for a corresponding treatment linked specifically with classical art, including humanist architecture. Some material already exists for such a venture, and even the people to undertake it. But by then, "Aspects of Form" will itself have become a classic.

F. I. G. RAWLINS

SOUTH AMERICAN INDIANS

Handbook of South American Indians

Edited by Julian H. Steward. Vol. 6: Physical Anthropology, Linguistics and Cultural Geography of South American Indians. (Smithsonian Institution: Bureau of American Ethnology, Bulletin 143.) Pp. xiii+715+47 plates. (Washington, D.C.: Government Printing Office, 1950.) 5 dollars.

WITH volume 6, the "Handbook of South American Indians" is complete except for the index. As forecast in the review of vol. 5, the subjects treated are early man (Part 1), physical anthropology (Part 2), and languages (Part 3); but in addition there is a long section on geography and plant and animal resources (Part 4).

The main contribution to Part 1 is a devastating summary by T. D. McCown of previous work, in which he shows that there has been much writing and little progress in the past thirty-five years. Apart from the Argentine remains, none of which has been proved to be of great age, there are various discoveries in Brazil, Ecuador and Lower California which have been held to constitute a Lagoa Santa race. He shows that there are far too few skeletons to support the claim that they form a race, and throws considerable doubt on the antiquity of the Ecuadorian examples. He gives Bird's discoveries of cultural material in South Chile a kindly mention, but does not refer to the single skull, apparently comparable with those of Lagoa Santa, which he was able to reconstruct from a cremation.

The uneven distribution of the available information is particularly apparent in the part dealing with physical anthropology. There are four sections—on skeletal remains, the living Indian, the Mestizos and the physical anthropology of Chile. The last three do not confine themselves to anthropometry, pigmentation and hair, but include also brief general discussions of blood groups and basal metabolic rates, and an account of the physical anthropology of the internal organs of the non-Indian inhabitants of Chile.

The vast subject of linguistics is ably summarized by J. Alden Mason, who emphasizes the incompleteness of our knowledge and disclaims any sort of finality. The plan of this section is a general introduction, followed by notes on each group, with a bibliography. The languages are grouped in larger divisions where possible, but a great many still have to be regarded as independent. A most useful map, in a pocket at the end of the book, accompanies this section.

The final section is much more than mere background. It contains a great deal of information of ethnological and archæological importance, including discussions of the domestication of animals and the origins of cultivated plants; for example, very valuable summaries of recent work on maize and cotton. A recent paper on the Cucurbitaceæ found in the Pre-ceramic deposits of North Peru by T. W. Whitaker and J. B. Bird is not mentioned, but this is an indication, not of omission, but of the inevitable delay in the publication of this volume. Map 7, a relief map of South America, which appears in this section, is so much reduced as to be of little use.

It is impossible to finish this brief notice without expressing once more the immense debt owed by all students of South America to those responsible for the compilation and publication of this "Handbook".

G. H. S. BUSHNELL

AMERICAN FORAGE AND PASTURE CROPS

Forage and Pasture Crops

A Handbook of Information about the Grasses and Legumes grown for Forage in the United States. By W. A. Wheeler. (Prepared under the auspices of the Field Seed Institute of North America.) Pp. xi+752. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1950.) 60*s*. net.

AS the United States turns to the grass, legume or other forage crop to restore lands, so Britain begins to approach the temporary ley scientifically as a fertility-building crop. Soil conservation may have more spectacular connotations than has the homely phrase, 'good husbandry', yet the aim of the agronomist in either country is to use pasture and

forage as improving crops, whatever the starting point. In one sense the practice of leaving land in grass for long periods may be conservation of soil; but we must realize that fertility is fruitfulness rather than some latent quality. One conceives a level of fertility as the rate of all those soil cycles of growth and decomposition which stimulate soil production. In any country, pasture-breaking or forage-cropping accelerates these processes.

Agriculturists in the United States are not only conservation-conscious. As Mr. Wheeler indicates in his introduction, there has also recently developed a spirit of inquiry in the attitude towards range grazings, and the indigenous species are being zealously explored.

For the foregoing reasons we should be acquainted with developments in the United States, and it is from this point of view that we judge Mr. Wheeler's encyclopædic work.

The collation of agricultural experience is an arduous task. The scientific evidence is often meagre, and a host of advisory bulletins is largely compounded from general observation and more than a little speculation. Mr. Wheeler has devoted almost one-half of his book to an agronomic treatise based, with due acknowledgment, on this type of publication. Difficult though the task may be, the material needs more facts and much more winnowing before it is acceptable as a work of reference. Even in view of the enormous amount of material used, and the impressive list of references, it would not be unfair to criticize the disjointed and often repetitive reading which this section makes, because much of it is clearly intended for continuous reading.

The serious deficiency, however, is in basic facts. A chapter on inoculation of legumes contains numerous statistics but little scientific information. The sponsors of the work might have invited specialists to contribute directly to this and another section on fertilizers. Mr. Wheeler shows better acquaintance with seed authentication; but his chapter on plant improvement which begins to leaven the treatise with stimulating thoughts eventually disappoints the reader through lack of detail in describing breeding methods.

A chapter on pests, diseases, weeds and poisonous plants makes brief reference to a good range of these visitations. Shades of the advisory leaflet are cast by the frequent appearance of the magic symbols DDT and 2,4-D.

References are listed at the end of each chapter. This may be the only practical way in which they could be cited, owing to the indirect nature of much quotation. A complete bibliography is appended under author and geographical indexes. The subject index is thorough in itself, but relates to pages, and the reader must work his way through chapter references in order to identify authors with their work.

The description of species which forms the major part of the book is historical and agricultural, as distinct from botanical. There is much repetition of the information contained in the general part of the book. To the non-American student of forage and pasture plants, however, this descriptive portion remains the more informative. This is a relative term. A volume clearly offered as a reference book should be a comprehensive yet scrupulously distilled source of information. The present edition cannot be said to attain these standards, and is therefore disappointing.

J. O. Green

ASPECTS OF X-RAY CRYSTALLOGRAPHY

Selected Topics in X-Ray Crystallography from the Delft X-Ray Institutes

Edited by J. Bouman. (Monographs on Theoretical and Applied Physics, Vol. 3.) Pp. xv+375. (Amsterdam: North-Holland Publishing Co., 1951.) 76*s*.

As its title implies, this book consists of a selection of articles by certain acknowledged experts in the field of X-ray crystallography, the common link being their proximity to each other in Delft. It is divided into eight sections ranging from purely general subjects such as structure analysis, distortion in crystals, and investigations in the biological field, to completely specialized ones such as the recrystallization of aluminium, investigations of photographic emulsions, and the degree of crystallinity in natural rubber. Certain types of apparatus, such as the reciprocal-lattice goniometer of de Jong and Bouman, the curved-crystal monochromator, and micro-cameras, are also dealt with in detail. It will be seen, therefore, that the range of interest is very wide, and opportunity is given for the various contributors to deal deeply and intimately with their own subjects. The book is well produced, and, despite occasional lapses in construction and spelling, the English is of a reasonable standard.

Yet the result is unsatisfactory. 'Selected topics' do not form a book, and the present volume has no general theme to give a sense of unity: the selection of contents appears to have been dictated rather by what the various contributors wished to write than by what the editors wished to include, and consequently the range is too wide to be of great value to specialists, and too casual to form a work of reference for the student.

Consider, for example, the first section—on structure analysis. This deals in great detail with the reciprocal lattice and its direct photography; but then there is a jump to the subject of termination errors in Fourier series. The main part of the subject—the determination of the relative phases of the structure factors—is completely omitted.

Moreover, it is difficult to see the justification for the placing of certain chapters. The section on structure analysis continues with chapters on the broadening of Debye–Scherrer lines and on stereographic pole figures. Still more surprising, in this same section there is mention of the Patterson function; but this turns out to be completely different from what is normally understood by that term, and is, in fact, concerned solely with diffraction by small crystals. Such departures from accepted nomenclature can be very misleading, and indicate a lack of contact with workers in other countries.

These faults could perhaps be tolerated if the various articles formed adequate reviews of the particular subjects. By this test, also, the book fails. The articles cover only the particular interests of the authors, and the lists of references are all quite short and far from comprehensive. (For example, although the biological field is included, the name of Bernal does not appear in the index.)

One must therefore regretfully conclude that the effort spent in producing this book has not been worth while. Despite the brilliance of some of the individual contributions, it is not a work that the specialist will feel he must have at his elbow, nor one to which the student can be referred.

H. Lipson

The Pharmacopeia of the United States of America (the United States Pharmacopeia)

Fourteenth revision (U.S.P. 14) and the First U.S.P. 14 Supplement. By authority of the United States Pharmacopœial Convention, Inc., meeting at Washington, D.C., May 14 and 15, 1940. Prepared by the Committee of Revision and published by the Board of Trustees. Pp. lv+1068+4. (Easton, Pa.: Mack Publishing Co., 1950.) 9 dollars.

THE fourteenth revision of the United States Pharmacopeia became official on November 1, 1950, only three and a half years after its predecessor. This short period is a sign of the rapid advance of therapeutics and a testimony to the energy of the Committee of Revision. The new work is about 10 per cent longer than its predecessor and contains nearly two hundred new articles.

The drugs thus introduced include acetanilide, aureomycin, chloramphenicol, chloroguanide (proguanil AN), chlorophenothane (DDT), dimercaprol (BAL), diphenhydramine (Benadryl), folic acid, heparin sodium, naphazoline (Privine, but not Priscol), nikethamide, raspberry juice, streptomycin, trimethadone (Tridione), tripelennamine (Pyribenzamine, but not mepyramine), tubocurarine, tyrothricin, and vitamin B_{12}. The list of omissions includes neoarsphenamine, rhubarb, senna, strychnine, tannic acid and thyroxin. Suramin is omitted and then reintroduced in the first supplement, which becomes official on the same day as the Pharmacopeia (for which this simplified spelling is adopted). Most of these changes were inevitable, though it is perhaps surprising that acetanilide and raspberry juice are introduced now, and that nikethamide was not introduced sooner. It seems likely that thyroxine will be reintroduced before long.

The Committee is to be congratulated on this work, which is very up to date and will be much studied not only in the various American republics where it has official status, but also in other countries which are busy preparing new editions of their own pharmacopœias. It is hoped that before long the appearance of the international pharmacopœia will simplify the labours of the various national committees. In the meantime, there is evidence of collaboration between the British and American committees. Most of the new American names are the same as the new British names, although the Americans evidently could not go so far as to adopt the therapeutically suggestive name 'leptazol' to describe the drug which they now introduce as pentylenetetrazol. J. H. G.

Physical Chemistry

By Prof. Walter J. Moore. (Prentice-Hall Chemistry Series.) Pp. ix+592. (New York: Prentice-Hall, Inc., 1950.) 6.65 dollars.

PROF. W. J. MOORE has written for university students who have acquired a knowledge of physics and of advanced mathematics. Indeed, the book affords a fine opportunity of testing a student's ability to apply his mathematical knowledge. As is to be expected, the author's approach to the subject is by the way of thermodynamics. The contents comprise: physicochemical systems, the laws of thermodynamics, chemical equilibrium, the kinetic theory, the structure of atoms and molecules, nuclear physics, particles and waves, chemical statistics, crystals, liquids, electrochemistry, surface chemistry, and chemical kinetics. Each chapter opens with a brief, scholarly written, historical account of the concept in question. This is followed by the formal treatment, which is precise, critical and thorough. The author does not make a gift of the mathematical expressions of the laws and relationships he discusses, but builds up his equations from first principles. Each chapter ends with abundance of questions, numerical problems and well-selected reading references. This is an excellent book, but suitable only for those whose mathematical equipment goes at least as far as partial differentiation. G. F.

Transformation Calculus and Electrical Transients

By Prof. Stanford Goldman. Pp. xiv+439. (New York: Prentice-Hall, Inc.; London: Constable and Co., Ltd., 1949.) 30*s*. net.

IN the theory of electric transients, the technique of the Laplace transform is a convenient central topic from which Prof. S. Goldman surveys impedance operators, complex variables, partial differential equations, and special functions, particularly the Bessel functions. The Laplace technique is developed from the beginning, and the more advanced student of electrical engineering, at or near postgraduate level, should benefit from the careful interweaving of pure mathematics with electrical theory. Attention is given to rigorous demonstration, but where proofs are omitted, for reasons of length or difficulty, references are supplied. The reader is expected to have a sound knowledge of the calculus, and an acquaintance with the concept of complex numbers and with elementary differential equations. The Laplace transform itself is studied as a transformation relating $f(t)$ to $F(s)$ (the author uses s in place of the more usual p) by the equation

$$F(s) = \int_0^\infty e^{-st} f(t)dt.$$

This mode of presentation is often more easily grasped by the technical student than the equivalent 'operational' calculus of Heaviside. The electrical theory excludes the non-linear network, but the study of the linear network is fairly comprehensive and up to date, including, for example, a discussion of the stability of feed-back amplifiers.

The Colloid Chemistry of the Silicate Minerals

By Prof. C. Edmund Marshall. (Agronomy, a Series of Monographs prepared under the auspices of the American Society of Agronomy, Vol. 1.) Pp. ix+195. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1949.) 5.80 dollars.

THIS useful monograph assembles in logical fashion the various aspects of our present knowledge of colloidal systems involving silicate minerals. After a summary of the main types of silicate structures the author discusses the distinctive properties of the zeolites, notably the adsorption of vapours. The major part of the book, however, deals with the clay minerals. Prof. C. E. Marshall has done a real service in thus bringing together the diverse facts on the physics and chemistry of clay systems which have been revealed in recent years by a variety of techniques. Each chapter is documented with a good list of references and a nice balance has been struck. The reader will benefit from the author's wide and critical reading in being guided immediately to the more important papers in the field. There is much in this short book of value not only to workers in the field of soil science but also to mineralogists and to chemists interested in colloidal phenomena generally.

BRITAIN'S SCIENTIFIC SHRINES (7)

By Eng.-Captain EDGAR C. SMITH, O.B.E., R.N.

THE NORTH-EASTERN COUNTIES

An itinerary through Yorkshire for a student of the history of science would take him from Sheffield in the south to Middlesbrough in the north, and from Whitby in the east, where stands the statue of Captain Cook (1728–79), to Settle in the west, the birthplace of Dr. George Birkbeck (1776–1841), who as the successor of Garnett at the Andersonian Institution, Glasgow, became imbued with the idea of furthering the education of the working classes. "Standing at the end of a long period of history, in which the fountains of learning had been enclosed for the benefit of a dominant caste [he] recaptured the tradition of the great medieval founders by taking knowledge to the people." A pioneer of mechanics' institutions, from 1804 onwards, as a London physician, he was always to be found in the ranks of the reformers. Birkbeck College, London, is but one of his monuments. He died on December 1, 1841, and was buried in Kensal Green Cemetery. Of Cook there are several memorials in Yorkshire. In Stewart Park, Marton, Middlesbrough, is a granite vase marking the site of the cottage in which he was born, and in the village of Great Ayton stands an obelisk built of stones from Cape Everard, close to Point Hicks, Victoria, Australia. The obelisk marks the site of a cottage occupied by his parents, but which in 1934 was taken down, transported to Melbourne and re-erected in Fitzroy Gardens.

Middlesbrough is a comparatively new town, for a century ago it was a mere village. It now has a population of some 144,000 and in it are to be seen the statues and memorials to the builders of its fortunes, Henry Bolckow (1806–78), John Vaughan (1799–1868), Joseph Pease (1799–1872), Sir Lothian Bell (1816–1904) and Sir Arthur Dorman. Sheffield, on the contrary, has been the home of the cutlery industry for centuries, and its Cutlers' Company was incorporated as long ago as 1624. One important event in its history was the introduction of the crucible process of making steel by Benjamin Huntsman (1704–76). A Quaker and watchmaker of Doncaster, Huntsman set out to produce a finer steel for his springs than he could buy. Removing from Doncaster to Handsworth, he there developed the crucible casting process and later on opened a workshop at Attercliffe, where the firm of B. Huntsman, Ltd., still produces high-class steels. In the Attercliffe old churchyard is its founder's tomb bearing the inscription "Benjamin Huntsman, died 21st June 1776 aged 72 years".

Among Sheffield's other famous men were John Roebuck (1718–94), the son of a Sheffield manufacturer; Mark Firth (1819–80), the steel maker who in 1879 founded Firth College, from which sprang the University of Sheffield; and Henry Clifton Sorby (1826–1908), the founder of metallography. The son of a tool-maker, and always a man of means, from the time he learnt how the Edinburgh investigator William Nicol (1768–1851) had devised a method of cutting thin sections of rocks for microscopical examination, Sorby devoted himself to the study of the structure of rocks and metals, writing some 240 memoirs. He was president in 1878–80 of the Geological Society, which on its centenary in 1907 sent an address to "The Father of Microscopical Petrography". Roebuck, unlike Firth and Sorby, saw little of Sheffield after his schooldays, for he was first a Birmingham physician, then a chemical manufacturer at Prestonpans, and in 1760 the founder of the famous Carron Ironworks, Falkirk. After a life of varying fortunes, he died at Bo'ness and was buried in the Carriden Cemetery. A low wall enclosed his grave and at the back was placed a well-designed marble tablet with a long inscription in Greek and Latin. In 1933 his descendants and the Carron Company carried out a complete restoration of both tomb and memorial.

From Sheffield it is only a few miles to the busy towns of Wakefield, Halifax, Bradford and Leeds, all of which demand notice. No scientific survey, however, would be complete without a visit to Sprotborough, near Doncaster, for here was Sprotborough Hall, the home of Sir Godfrey Copley, Bart. (d. 1709), who by his will left £100 to the Royal Society for "improving natural knowledge". He had been member of Parliament for Thirsk, had held public offices and from 1691 was greatly interested in the affairs of the Royal Society. He died in Red Lion Square, Holborn, London, but was buried in Sprotborough Church. His £100 was allowed to lie idle for some time, but awards were made in 1731, 1732 and 1736, and then the money was used to found the Copley Gold Medal, now the oldest and most famous of prizes in the world of science. Many of its recipients have been mentioned in the course of this survey, but it is of interest to recall that in the forty-six years 1749–95 inclusive, during which forty-one awards were made, no fewer than six of the recipients were Yorkshiremen. In 1749 the Medal was given to John Harrison, a native of Wragby, near Wakefield, for his "Curious Instruments invented and made by him for the exact Mensuration of Time"; in 1759 it was given to Smeaton for his "Curious Experiments concerning Water-wheels and Windmill-sails", and in 1773 Priestley received it for his "Many Curious and Useful Experiments on Different Kinds of Air". Three years later, Cook was awarded it for his "Paper containing the Method he had taken for Preserving the Health of the Crew of H.M.S. Resolution"; in 1783 it was given to the nineteen-year-old boy John Goodricke (1764–86) of York, for his "Discovery of the Period of the Variation of Light in the Star Algol"; and in 1795 to Jesse Ramsden (1735–1800), the son of an innkeeper at Salterhebble, near Halifax, for his "Various Inventions and Improvements in Philosophical Instruments". Harrison (whose wonderful chronometers, it will be remembered, were repaired and set going again by the late Lieutenant Commander Rupert Gould), like Copley, died in Red Lion Square, London, but was buried at Hampstead. Priestley's birthplace was Fieldhead, Birstall, near Leeds, and to Leeds he came from Warrington in 1767 at the age of thirty-four to be minister of the old Mill Hill Unitarian Chapel, a position he held for six years. In Leeds he found much congenial society, having among his friends the Rev. John Michell (1724–93), the rector of Thornhill, who had been Woodwardian professor at Cambridge. In his "Memoirs", Priestley wrote: "In writing the 'History of Discoveries Relating to

Vision', I was much assisted by Mr. Michell the discoverer of the method of making artificial magnets. Living at Thornhill not far from Leeds I frequently visited him and was very happy in his Society as I was also in that of Mr. Smeaton who lived still nearer to me." Smeaton's home was Austhorpe Lodge, Whitkirk, and he died there on October 28, 1792, and was buried in Whitkirk Church. His monument, surmounted by a representation of the Eddystone Lighthouse, was recently reconditioned by the joint efforts of the Smeatonian Society of Engineers and the Newcomen Society. There is no statue of Smeaton, but several of Priestley, one being in the centre of Leeds and another at Birstall. The town of Halifax also has other scientific associations, for here Herschel taught, played and conducted before going to Bath; while in the neighbourhood are Bradley, the birthplace of Sir Henry Savile (1549–1621), provost of Eton and warden of Merton College, Oxford, and Warleywood, the birthplace of Henry Briggs, whom Savile chose as the first Savilian professor of geometry. Two other scientific worthies who came from the same district were Dr. John Radcliffe (1650–1714), a native of Wakefield, whose name is perpetuated in Oxford by the Radcliffe Library, the Radcliffe Infirmary and the Radcliffe Observatory, the last of which has been removed from Oxford to South Africa, and Flamsteed's friend and collaborator, Abraham Sharp (1651–1742), who spent his earlier and later years at Little Horton, near Bradford, and who is buried in Bradford Church. Leeds, too, can claim other distinguished men of science, for Dr. Isaac Milner (1751–1820), who for many years was Lucasian professor and president of Queens' College, Cambridge, was the son of a weaver of the City, and the redoubtable and wealthy Richard Sheepshanks (1794–1855) was the son of a Leeds cloth manufacturer. Parson, lawyer, mathematician, astronomer, a renovator of our weights and measures, known to Herschel, Babbage, Whewell, Airy, Baily and a crowd of others, Sheepshanks, whose bust is in Trinity College, Cambridge, was a rare fighter, and of something he wrote De Morgan said that it will "remain to illustrate the science of our century and will furnish ample material to the future collectors of our literary curiosities". From the time Sheepshanks left college, his sister lived with him, and as his heiress she presented £10,000 to Cambridge for research, and gave his instruments to the Royal Astronomical Society.

Before leaving the West Riding of Yorkshire, two other places are worthy of mention: Thurlestone, near Penistone, was the birthplace of Nicolas Saunderson (1682–1739) who, though like Gough of Westmorland blinded in infancy through smallpox, yet became the successor of Whiston as Lucasian professor at Cambridge; while at Sharow, near Ripon, lies Piazzi Smyth, buried beneath a pyramidal stone recalling his much-read book "Our Inheritance in the Great Pyramid". He had retired from the post of Astronomer Royal for Scotland in 1888, and it was at his Yorkshire home near Ripon he carried on his spectroscopic investigations.

To the north of Ripon, and in the North Riding, lie Richmond and Northallerton, the former being the birthplace of Sir Edward Banks, the builder of London Bridge, and of Henry Greathead (1757–1816), the pioneer of the lifeboat, and the latter recalling the work of Colonel William Lambton (1756–1823), who was born at Crosby Grange nearby. Though of humble parentage, by 1781 Lambton had become an ensign. After some active service in India, he was employed on surveying, and from his geodetical work sprang the Great Trigonometrical Survey of India, Sir George Everest (1790–1866) being his chief assistant. Travelling eastward from Northallerton across the Pickering Moors, near Pickering itself is found the village of Cropton, the birthplace of the whaler-captain and magnetician, William Scoresby (1789–1857), who lectured "to the assembly of beauty, fashion and philosophy" at York in 1831. Not long after this, he took holy orders and during 1839–47 was vicar of Wakefield. He died at Torquay. Still farther east and eight miles inland from Scarborough is Brompton Hall, the ancestral home of the Cayley family. The papers of Sir George Cayley (1773–1857), the sixth baronet, have recently been recovered, and they show him to have been a real pioneer in aeronautics. An exhibition of Cayley relics is now being held at Scarborough.

The historic city of York, standing at the junction of the three Ridings, with its splendid Minster, its Archbishop's Palace and its well-known Yorkshire Philosophical Society, brings to mind the two seventeenth-century mathematicians and astronomers, William Neile (1637–70) and William Gascoygne (1612 ?–44), both of whom died in their thirties. Neile was an archbishop's grandson and was born at Bishopthorpe. At Oxford and in London he became known to Wilkins, Seth Ward, Wren and others, was made a member of Council of the Royal Society and at his home in White Waltham, Berkshire, had an observatory. He died there on August 24, 1670, and there he is buried and has his monument. His contemporary, William Gascoygne, was the son of Henry Gascoygne, of Thorpe-on-the-Hill, in the parish of Rothwell, near Leeds. He was as much interested in astronomy as were Horrocks and Crabtree, corresponded with them, and to-day is known to have been the first inventor of the wire micrometer and its application to the telescope. It is considered that he was born not later than 1612, but it is known for certainty that he died at the Battle of Marston Moor, near York, on July 2, 1644, fighting on the side of the Royalists. York is the home of the firm of Cooke, Troughton and Simms, Ltd., which began in the shop opened in 1837 at 50 Stonegate by Thomas Cooke (1807–68). He proved a worthy successor to the instrument makers of the eighteenth century and has been called the 'English Fraunhofer'. He died while engaged on the famous 25-in. equatorial for the Gateshead engineer Robert Stirling Newall (1812–89), who gave it to Cambridge.

Durham and Northumberland, in common with other counties, have given birth to men who in one way and another made their mark in the world of science. Thus the records of the nineteenth century contain the names of such outstanding men as Lord Armstrong and Sir Joseph Wilson Swan. But looking back over the centuries, the year 1701 saw the birth of the somewhat eccentric mathematician William Emerson, a native of Hurworth, near Darlington. For a time he followed his father as a schoolmaster, but took to writing text-books. At the age of sixty-two he walked to London and there he died at the age of eighty-one. His books almost formed a mathematical encyclopædia. Edward Hussey Delaval (1729–1814) belonged to an ancient Northumbrian family. He became a Fellow of Pembroke Hall, Cambridge, in 1759. He was also elected a Fellow of the

Royal Society and in 1766 received the Copley Medal for his "Experiments on the Specific Gravities of the Several Metals". Afterwards he was much concerned in the lightning conductor controversy. Dr. Charles Hutton (1737–1823), the son of a Newcastle colliery worker, started with little education, but rose to be the professor of mathematics at the Royal Military Academy, Woolwich. He was the leading authority on gunnery, and a notable figure in the Royal Society. He retired in 1807 and was succeeded by Olinthus Gregory, but he lived another sixteen years. At his death he was buried at Charlton, Kent. His bust he bequeathed to the Newcastle upon Tyne Literary and Philosophical Society, which had been founded in 1793. Dr. George Peacock (1791–1858), of Thornton Hall, Denton, in Durham, another mathematician, belonged to a later generation. Entering Cambridge at the age of eighteen, he assisted in founding the Analytical Society, which, for the benefit of students, published a translation of the "Differential Calculus" of Lacroix. A man of great charm, in 1836 he became Lowndean professor of astronomy, and three years later also Dean of Ely, where he is buried. At his death, Airy wrote to his widow: "All my debts to other friends in the University added together are not comparable to what I owe to the late Dean . . .". Airy himself had associations with the North, for he was born at Alnwick, where his father was an excise officer.

Whatever interest, however, may be felt in the careers of these and other men of science, for many, the history of Durham and Northumberland is associated with their collieries, railroads, locomotives and ships. Of the leading pioneers of the locomotive, Matthew Murray (1765–1826) of Leeds, William Hedley (1779–1843), John Urpeth Rastrick (1780–1856), George Stephenson (1781–1848), Timothy Hackworth (1786–1850), Robert Stephenson (1803–59), and Sir Daniel Gooch (1816–89) were all born on the banks of the Tyne, and the construction of their historic locomotives "Puffing Billy", "Wylam Willy", "Blucher", "Locomotion" and "Rocket", of the Stockton and Darlington Railway, as also of the Liverpool and Manchester Railway, are landmarks in the history of land transport. There are many monuments to these north-country pioneers, and as recently as 1947 a tablet was placed on Hackworth's house at New Shildon, Durham, while two years later, through the action of the North-East Coast Institution of Engineers and Shipbuilders, the cottage at Wylam in which George Stephenson was born was transferred to the custody of the National Trust.

1951 POPULATION CENSUS OF ENGLAND AND WALES

THE detailed results of the fifteenth Census of Population of England and Wales, taken on April 8, 1951, will be eagerly awaited, as it is twenty years since the last census was taken, 1941 being the first break in the regular series of decennial censuses dating from 1801. It is, however, forty years since there last was a simultaneous count of the population of all the constituent areas of the United Kingdom and the Irish Republic. In 1951 the Census authorities of England and Wales, Scotland, Northern Ireland, the Channel Islands, the Isle of Man and the Irish Republic acted in concert, and a Census was taken on the same day in all these territories. It is to be hoped that this arrangement will continue in future, as the volume of migration between different parts of the British Isles is not inconsiderable and the territorial units which are of interest to students of population are generally larger than the unit covered by one Census authority. It would be of great assistance if definitions and tables in the full reports could be standardized, and summary tables relating to Great Britain, the United Kingdom, and the British Isles as a whole published.

A full appreciation of the results of the Census, which contained a number of new questions asked for the first time on this occasion, will have to await the publication of the detailed reports. The time-lag between Census day and publication will, however, be considerably shortened in England and Wales, for the Registrar General proposes to analyse a sample of 1 per cent of the Census schedules and to publish main tabulations relating to this sample within a year of enumeration.

The preliminary report*, which has recently been published, is, as is customary, based not on an analysis of the actual Census schedules but on a count made from summaries supplied by the local Census officers. Its purpose is restricted, and its main function is to give provisional figures for the total population, classified by sex, of all local-government areas in the country down to district level. For the social scientist its main importance lies in the information it gives on total numbers and on the geographical distribution of the population.

Table 1. Total Populations and Rates of Change in the British Isles, 1921–51

	Population (thousands)			Rate of change per cent per decennium	
	1921	1931	1941		
England (excl. Monmouth)	35,230	37,359	41,148	+6·0	+4·9
Wales and Monmouth	2,656	2,593	2,597	−2·4	+0·1
England and Wales	37,887	39,952	43,745	+5·5	+4·6
Scotland	4,882	4,843	5,096	−0·8	+2·6
Great Britain	42,769	44,795	48,841	+4·7	+4·4
Northern Ireland	1,258*	1,243*	1,370	−1·2	+5·0
United Kingdom	44,027	46,038	50,210	+4·6	+4·4
Islands in the British Seas	151	143	158	−5·4	+5·3
Irish Republic	3,096*	2,933*	2,959	−5·3	+0·4
Grand total	47,274	49,114	53,327	+3·9	+4·2

* Estimated.

The total populations of the different constituent parts of the British Isles are shown in Table 1, together with their rates of change. To make for easier comparability the rates of change for the twenty years 1931–51 have been converted to average rates for decennia. The table shows that for the British Isles as a whole the population increased at a slightly higher rate between 1931 and 1951 than during the decennium 1921–31. In the United Kingdom, however, the rate of increase remained practically stationary at 4½ per cent for ten years. Within the United Kingdom, Wales, Scotland and Northern Ireland increased in population during 1931–51 after registering a decline in total numbers during 1921–31. This decline, however, was probably due to a negative balance of migration.

Confining our attention to England and Wales, two features of interest must be pointed out. In the first place, for the first time in the past century there has been a net gain of population due to migration. This

* General Register Office. Census 1951, England and Wales. Preliminary Report. Pp. xxiii+52. (London: H.M. Stationery Office, 1951.) 5s.

gain is estimated at about half a million for the period 1931–51. It is due to the return of British subjects resident abroad, the demobilization of Allied and Dominion soldiers in Britain, and to a small part to the immigration of refugees and displaced persons. The net balance of migration from other parts of the United Kingdom can only be estimated since the introduction of the National Register in 1939, and it is believed that this factor accounts for an increase of between 250,000 and 300,000 since that time.

The second feature that needs comment is that the decennial rate of increase is the lowest ever recorded, in spite of the net gain from migration to which reference has already been made. It is true that since 1931 there have occurred 360,000 deaths, estimated as being due to the War. But the losses of the First World War were much heavier, both absolutely and relatively, than those of the Second, and yet the rate of increase between 1911 and 1921 amounted to 4·9 per cent in spite of a net outward balance of migration. It is therefore difficult to accept the statement in the text that "there is no sign of any tapering away of the successive increments such as would normally be expected to herald the early approach of an ultimate population maximum". The Registrar General's technical advisers must be aware that figures of total population cannot provide any reliable guide to prospects of future development of population, and it would have been wiser to wait for the more detailed information on age distribution and fertility before committing oneself to this view on the future. Taking recent registration figures into account, it would be very surprising if the rate of increase between the present Census and the next will not be substantially lower than 4½ per cent per decennium.

The overall rate of increase for the country as a whole masks considerable variations in the rate of increase for different regions. The geographical distribution of the population has changed since 1931, and the proportionate importance and rates of increase of the different standard regions are shown in Table 2. It is clear from this table that the eastern and southern regions of the country continue to grow at the expense of the north and the north-west. But a new tendency has become evident since 1931. The rate of increase of London and the south-east, which was well above the national average during the previous decennium, has fallen spectacularly and the proportionate importance of that region has decreased. Conversely, the rates of increase of the Midland and south-western region have shot up. It will be interesting to analyse the changes in age, occupational and industrial distribution of the populations of those regions, but this will not be possible until the detailed tables are published.

Table 2. Proportionate Populations in Different Regions of England and Wales, with Decennial Rates of Change

Region	Population per cent total			Rate of change per decennium	
	1921	1931	1951	1921/31	1931/51
Eastern	5·8	6·1	7·1	+11·5	+12·8
Southern	5·1	5·3	6·1	+11·3	+11·4
Midland	9·4	9·4	10·1	+ 5·6	+ 8·7
South-western	6·6	6·5	6·9	+ 4·1	+ 7·5
North Midland	7·3	7·4	7·7	+ 6·4	+ 7·2
London and south-east	25·0	25·9	24·9	+ 9·2	+ 2·7
East and West Riding	9·9	9·8	9·4	+ 4·4	+ 2·1
North-western	16·0	15·5	14·7	+ 4·0	+ 2·0
Northern	8·0	7·6	7·2	+ 0·8	+ 1·6
Wales	7·0	6·5	5·9	− 2·4	+ 0·0
England and Wales	100·0	100·0	100·0	+ 5·5	+ 4·6

Some comments have been made on the change in the proportion of the urban population. It appears as though the percentage classified as urban has decreased slightly since 1931. The report shows that this decrease took place almost entirely after 1939. But, again, the figures must be interpreted with caution. There have been no changes in local-government boundaries since 1939, and it is possible that the slight increase in the rural population is merely a reflexion of the increasing tendency of city dwellers to move to the peripheral suburbs, some of which may be classed as rural districts. A detailed study of this question will have to await the publication of the report on place of residence and place of work.

The above remarks make it clear that only very provisional conclusions can be drawn from the preliminary report. New light will be thrown on many problems, however, when the final volumes begin to come out. The abnormally long interval between the past two censuses has been a great obstacle in the way of those who are interested in local or regional studies. It is to be hoped that there will never again be so long an interval between two censuses. Provision was made in the Census Act of 1920 for a census to be taken not more frequently than once every five years, and it is to be hoped that the provisions of the Act will be used and a new census taken in 1956.

E. Grebenik

SOME EXPERIMENTAL WORK CARRIED OUT IN PHYSICS WITH THE LARGER HARWELL PILE

THIS article describes a few of the experiments which have been carried out in physics at Harwell with the larger atomic-energy pile known as BEPO.

Neutron Crystallography

A double-crystal neutron spectrometer, which utilizes a collimated beam of thermal neutrons from the *thermal column*, has been designed and made for work on neutron crystallography[1], and has been used, among other things, for checking theoretical predictions regarding the intensity of reflexion of monochromatic neutrons from single crystals, with a view to the ultimate use of such crystals in structure analysis. The use of single crystals is clearly desirable if adequate progress is to be made in neutron crystallography, but has been restricted by the appreciable extinction effects arising from the large crystals that have hitherto been employed. From a series of intensity measurements, made under carefully controlled conditions, it has been found that the theoretical intensity relationships worked out by Bacon and Thewlis[2], and Bacon and Lowde[3], according to which the integrated intensity of reflexion is dependent, for thick crystals, not on the structure factor but largely on the degree of mosaic spread, are in fact valid; further study[4], however, has led to the discovery that relatively large crystals can be used if they are of the right shape. For potassium bromide, a crystal typical of many in this field, a specimen 1 cm. long and 2 mm. square in cross-section, permits the proportionality between integrated intensity and structure factor to be retained.

Further, the permitted cross-section may be increased to 4 mm. square by immersing the crystal in liquid air and thus increasing the degree of mosaic spread.

The problem of using single crystals has been attacked on somewhat different lines by Lowde[5], who has constructed a small-scale neutron spectrometer in which crystals of dimensions of only 1 mm. or so are employed. To gain the necessary intensity, the incident radiation is not monochromatized but comes straight from the pile. A convergent beam is used, the crystals under investigation and a special multiple boron-foil ion chamber[6] being set up so that a given crystal plane can reflect into the ion chamber only neutrons of, or near, a particular (chosen) wave-length. The peak counting-rate of the crystal rocking curve then gives the integrated reflexion for the crystal plane in question. The weakness of the method is the inherently possible confusion of orders of a given reflexion, but in favourable cases the method is very encouraging. The peak-to-background ratio obtained with single crystals of naphthalene, for example, is high enough to encourage the hope that information about hydrogenous structures is within our reach, without the need for the substitution of hydrogen by deuterium.

Another way in which the double-crystal neutron spectrometer has been used is for the study of the electron distribution in graphite[7]. X-ray measurements have shown that the $10\bar{1}0$ reflexion relative to the $11\bar{2}0$ is about 85 per cent stronger than expected, and the $10\bar{1}1$ reflexion relative to the $11\bar{2}2$ is about 80 per cent stronger. This could arise if the atomic positions in graphite were other than those generally accepted, or alternatively the electronic configuration might be different from that usually assumed. If the explanation of the anomalous intensities is, in fact, concerned with electronic configuration and not with incorrect atomic positions, then the intensities of reflexion obtained by neutron diffraction should no longer be anomalous, since the neutron scattering is a nuclear phenomenon and no part is played by the electrons. In the event, the measured neutron intensities were found to agree with the theoretical intensities to within 5 per cent, showing that the accepted atomic positions are substantially correct, and that an asymmetric electron distribution probably occurs in graphite.

Irradiation Experiments

The effect of pile irradiation on a number of materials has been studied by X-ray diffraction methods and by electron microscopy. For example, it has been found that the strength of various polymers is seriously affected by such irradiation. Some polymers, for example cellulose and its derivatives and collagen, appear to break down to about the same extent in both the crystalline and non-crystalline parts, whereas others, such as nylon and keratin, first break down in the non-crystalline regions[8].

Some very interesting effects have been obtained by irradiating by slow neutrons in BEPO a copper–gold alloy containing 30 per cent (atomic) of gold, in its ordered state[9]. The first result of the irradiation appears to be an increase of order, as evidenced by a decrease in unit-cell dimensions, and the appearance of satellite reflexions on each side of certain superlattice reflexions, which may possibly arise from the existence of regularly arranged 'domains', although it is too early to be sure of this. The effect is accompanied by a decrease in electrical resistivity. At a later stage the resistivity increases and additional X-ray reflexions occur, the origin of which is not yet understood; but at no stage have the superlattice reflexions shown any loss of intensity. It is possible that further irradiation may produce such a loss, but this question must await further experiment.

In contrast with the above results, it is interesting to note that the irradiation of a similar alloy in a fast neutron flux produces the opposite effect, that is, the alloy becomes disordered[10].

Neutron Spectrometer Experiments

A beam of neutrons from a nuclear reactor will consist of a group of neutrons which have been in approximate thermal equilibrium with the moderator, and a group with energies lying between 2 MeV. and thermal energies. It is often useful to be able to select from this distribution those neutrons the energies of which lie in a narrow band. This may be done either by using the wave property of neutrons to reflect a certain wave-length with a crystal (as in neutron crystallography), or by artificially modulating the beam and then timing the neutrons over a measured path. Spectrometers working on each of these principles are in use with the Harwell pile. The crystal spectrometer is used to obtain a monochromatic neutron beam with an energy anywhere in the range 0·05–10 eV., and a mechanical time of flight spectrometer using a cadmium shutter to pulse the beam is used to select neutrons with energy anywhere between 0·001 and 0·10 eV.

These instruments have been used to measure the transmission of samples of several elements as a function of neutron energy. From the measured transmission the probability that a neutron will interact with a nucleus (that is, the cross-section) can be calculated. This cross-section will represent the sum of the probabilities for several different types of scattering and absorption processes. In some cases one process will predominate (for example, absorption in hafnium) and then it is possible to study it alone. In other cases it will be necessary to analyse the 'total' cross-section to find the cross-sections for several processes. The elements molybdenum, bromine, zirconium, hafnium and selenium have been studied in this way, and the results on the first four have been reported[11].

Filtered Neutrons

Neutron beams consisting solely of very low-energy neutrons are useful for certain experiments. It is possible to obtain such a beam by placing a block of polycrystalline material with a low absorption cross-section in the neutron beam, when those neutrons with wave-lengths greater than twice the maximum inter-planar spacing in the crystals will pass through almost unattenuated and neutrons with shorter wave-lengths will be scattered out.

The scattering of neutrons, with wave-lengths too great for Bragg reflexion, by crystalline materials is mainly due to the interaction of the neutrons with the thermal vibrations of the lattice. The scattering in this case will be inelastic, and the gain in energy by the neutron is a measure of the thermal vibration frequency. This phenomenon has been studied in polycrystalline samples of beryllium and iron with a beam of lead-filtered neutrons. The thermal vibration frequency of the C—H bond has also been measured by this method.

Angular Correlation Experiments

Measurements have been made of the angular correlation between the alpha-particles and gamma-rays emitted in the reaction $^{10}B(n,\alpha)^7Li(\gamma)^7Li$, and between fission fragments and gamma-rays in the slow-neutron fissions of uranium-235. In the boron experiment[12], the distribution was spherically symmetrical to 2 per cent; there was therefore no evidence from this experiment that the spin of lithium-7 is other than $\frac{1}{2}$. In the fission experiment, significant deviations from symmetry up to 20 per cent were observed, and in addition a delayed gamma-ray, of half-life between 10^{-8} and 10^{-7} sec., was observed.

Thin layers of the separated isotopes boron-10 and lithium-6 have been irradiated in a gridded ionization chamber filled with an argon – carbon dioxide mixture, and a 'kicksorter' is used to measure the ionization produced by the disintegration particles relative to that of polonium alpha-particles. The energy-loss to produce one ion pair is found to depend on the velocity of the ionizing fragment.

The gridded ion-chamber technique has also been used to study the alpha spectrum from the break-up of beryllium-8 following the beta-decay of lithium-8. A neutron beam passes through a rotating shutter with equal on and off times of 0·5 sec., and strikes a foil of natural lithium. The delayed alpha-particles are recorded in a thirty-channel 'kicksorter' when the shutter is closed. The alpha-spectrum was studied between 0·5 and 8 MeV., and only the broad excited level of beryllium-8 at 3 MeV. seems to be involved. From a comparison of the total number of delayed alpha-particles, with the number of prompt events from the $^6Li(n,\alpha)$ reaction, recorded with the shutter open, a value of 0·042 barn has been obtained for the capture cross-section of lithium-7.

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VERTEBRATE PALÆONTOLOGY AND EVOLUTION

A DISCUSSION on "Vertebrate Palæontology and Evolution" was held jointly by Sections C (Geology) and D (Zoology) of the British Association on August 10 at Edinburgh. Prof. T. S. Westoll (Newcastle upon Tyne) began by stressing that only a few selected parts of a very productive field of inquiry could be dealt with at the meeting. Palæontology, essentially a historical and observational discipline, must strive to correlate its findings with the potentially or actually experimental investigations of living organisms.

There is good evidence from the fossil record of evolutionary changes of different orders of magnitude—from phyletic ('micro-') evolution of slow change without extensive reorganization of structural pattern, to adaptive radiations involving the emergence of new structural patterns of divergent adaptive importance. Branches in an adaptive radiation may, after a comparatively short period of relatively rapid divergence, survive through a long period of little further essential change, in which phyletic evolution can often be traced. Adaptive radiations can occur at a great variety of systematic levels, from assemblages of orders (for example, Placoderms) or sub-orders (for example, Perissodactyls) through families (Percoidea) and genera and species (Darwin's finches), probably down to demes. The important question is whether mega-evolution, involving really striking modification of structural pattern, is different in nature.

Orthogenesis is a concept long applied to palæontological series. Closer investigation frequently shows greater complication than was at first thought. Furthermore, the more or less vitalistic or metaphysical language in which orthogenesis is so often befogged is found unnecessary by many recent workers. The imperfect geological record and incomplete fossil remains have contributed to an oversimplification in many evolutionary studies.

In cases of 'macro-' and 'mega-evolution' the fundamental problem is in the stability of structural pattern. Phyletic evolution involves the 'plastic' modification of the same pattern; in the other cases a presumed ancestral pattern has been modified beyond its limits of 'elasticity', so that great modifications and adjustments have been made and then stabilized. In such cases, because of limitations imposed by genetic constitution, development-mechanics and structural factors, independent parallel evolution is not infrequent (secondary palate in Theriodontia, cannon-bones in Artiodactyls, etc.); and the essentially *adaptive* nature of the process is shown by convergence in such cases as Equidæ and Litopterna. Organism and environment each exert 'pressure' on the other; and within the limitations of his field the palæontologist must appreciate this dynamic relationship.

Analysis of some selected case-histories was undertaken by Prof. Westoll, and he showed that the evolution of the horses was not orthogenetic, but that at least three succeeding adaptive offsets have taken place. Factors involved in the radiation of actinopterygian and placoderm fishes were discussed in relation to adaptive modification of pattern. A new analysis of the history of the Dipnoi (a remarkably clear and simple 'mega-evolution' at ordinal level) reveals an integration of finite steps of offset from the early stock, with more-or-less persistent groups settling down at certain stages until replaced by more fully adapted forms. The history of emergence of a major group must be very complex, but there is reason to believe that it took place also by the integration of successive offsets. It was noted that growth-studies are of great importance in this field.

Dr. W. E. Swinton (British Museum, Natural History) reviewed the geological history of dinosaurs, a group usually regarded as diphyletic. The two groups—the Saurischia (large herbivores and bipedal carnivores) and Ornithischia (bipedal and armoured quadrupedal herbivores)—both developed from small, bipedal Triassic Thecodonts. These last had only light armour of bony plates on the back. Though many dinosaurs attained very large size, this is not universal.

Giantism is well shown in the Saurischia. One line culminates in the late Cretaceous *Tyrannosaurus*. The Sauropoda, mainly of Jurassic age, reached some

thirty tons in weight, partly compensated by their aquatic habit. The Ornithischia show greater adaptive diversity but less extreme growth in size. Bone-development is often striking. Thus, while the duck-billed *Anatosaurus* (*Trachodon*) has no special outgrowths, late Cretaceous relatives (*Corythosaurus*, *Lambeosaurus*, *Parasaurolophus*) developed remarkable outgrowths of the premaxillaries or nasals or both, which carry the nasal passages and may have served as air-storage tubes during diving. This is an allometric modification of existing bone. Other bipedal Ornithischia (*Tröodon-Pachycephalosaurus*) show no excessive growth, but have massive thickening of the frontals and parietals. Brain-casts indicate enlarged pituitary bodies, suggesting acromegalic hyperostosis. The Ceratopsian skull has a characteristic frill of bone over the neck region, with variable development of nasal and supraorbital horns. These are developments of the skull-bones. Again, a large pituitary body is indicated by brain-casts. The relatives of *Stegosaurus* show no thickening of skull-bones, but remarkable plates are found on the body. The pituitary body, so far as known, is small.

It is suggested, continued Dr. Swinton, that very great body size or abnormal bone-development may be hormonally controlled, hereditary and without sex-linkage. Jurassic Saurischia show giantism but no hyperostoses; Cretaceous Ornithischia show hyperostoses but no real giantism. These developments correlate with two widespread Mesozoic temperature minima. This 'phylogenetic pituitarism' suggests that the diphyletic origin of the dinosaurs needs reconsideration.

The relationship between mammals and Synapsid reptiles were then examined by Mr. F. R. Parrington (Cambridge). The Permian and Triassic mammal-like reptiles, especially those of South Africa, first discovered about a century ago, have long been known to resemble Monotremes in their post-cranial skeleton and to develop mammal-like cranial and dental characters. There is general agreement that mammals originated from the later (Triassic) Theriodont members of the Synapsida, but precise origins are obscure. This is largely because of the paucity of fossil theriodonts and mammals from about the end of the middle Triassic through the Mesozoic.

Two upper Triassic skeletons described by Broom showed remarkably close approaches to mammalian conditions, and were placed in the new sub-order Ictidosauria. To this sub-order are now referred a few fragmentary fossils once regarded as advanced Cynodonts, and the remarkable *Tritylodon* and its allies, long regarded as mammals. *Bienotherium*, a Chinese Tritylodontid, was described by Young, and shown by Watson to retain the reptilian jaw-articulation and to be probably a Cynodont derivative. Kühne has fully confirmed this by his study of the European relative *Oligokyphus* (Rhætic and Lower Lias of Somerset, etc.). The Ictidosauria so defined show a variety of tooth-crown structure.

Certain teeth from Rhætic – Lower Liassic deposits in Britain and Switzerland are still more mammalian in appearance, and suggest comparison both with Symmetrodonts and with Pantotheres, two orders of Mesozoic mammals, the rare remains of which have been fully monographed by Simpson. Two other orders—Triconodonts and Multituberculates—have been regarded as of unknown but separate Theriodont origin, but since then the Tritylodontids, earlier regarded as Multituberculates, have turned out to have reptilian jaw-articulations.

Since there is much diversity of form of the cheek-teeth both in Mesozoic mammals and in Ictidosaurs and other late Theriodonts, and since there is some parallelism, the question arises whether mammals form a true taxonomic unit, or are polyphyletic. The evidence is equivocal, and has been used to defend quite diverse views. But there can be no doubt that many 'mammalian' skeletal features had already been evolved by the Theriodonts. Only the jaw-articulation and middle-ear structures are clear points of distinction. Much of the argument turns on whether such structures are likely to be similarly modified by parallel evolution. The recent important discoveries give hope that palæontology may before long clarify this problem, and perhaps lead to a solution.

Dr. G. S. Carter (Cambridge) also discussed the problem of mammalian origins by focusing attention on the Monotremes, and by using the methods of comparative morphology. The Monotremes are in many respects remarkable structural intermediates between reptilian and mammalian patterns. The phylogenetic position of the Monotremes has been very diversely argued: at one extreme Brazier Howell, on the evidence of the shoulder-girdle, suggests that they evolved from an early reptilian stock quite distinct from that leading to other mammals; at the other, W. K. Gregory recently maintained that they are aberrant marsupials. The most generally accepted view is that they diverged from an early mammalian stock in Triassic or possibly Jurassic times.

The modern Monotremes are specialized: *Ornithorhynchus* is aquatic, and *Echidna* (=*Tachyglossus*) is believed to be descended from aquatic ancestors. Feeding habits are also specialized. Both Monotremes are mammalian in hair, diaphragm, lungs, breathing, heart and blood system, kidneys and most features of skull and jaws. The physiology, so far as is known, is mammalian except in a few characters. Even the small blood-corpuscles are mammalian in form, an adaptation allowing smaller capillaries and a higher metabolic rate. A few characters are worth special attention. Control of body-temperature is by increase of muscular activity when cold; control by sweating is probably absent or slight, and variation of body-temperature with external temperature is greater than in mammals, but less than in living reptiles. Four striking features of Monotremes were noted: the shoulder-girdle retains coracoids and interclavicles, and the fore-limb shows a reptilian posture—it is suggested that in the latter feature *Ornithorhynchus* is adaptively specialized to swimming by means of the fore-limbs, whereas *Echidna* is thought to have had aquatic ancestors; the female generative system is almost entirely reptilian, but mammal-like features are the relatively small yolk and a crude development of a follicular cavity; the monotreme eye is entirely reptilian except for two features, the chief being the superior oblique muscle which turns through a pulley and has moved its attachment area as in mammals; and finally, though facial musculation is developed in Monotremes, a difference from living reptiles, the pattern is different from that in placental mammals.

Monotremes and placental mammals probably diverged when many characters of the soft parts and physiology as well as the skeleton were mammalian, some still reptilian. Most of the monotreme characters are either completely mammalian or completely reptilian: few are intermediate. This implies a series of consecutive changes rather than a grand

simultaneous transformation. Such a view is not opposed by the palæontological evidence.

In the ensuing general discussion Prof. Westoll noted that the Theriodonts show several features indicating the piecemeal acquisition of mammalian characters. If one bases classification solely on the presence or absence of the mammalian temporomandibular joint, then pouch-young of some marsupials and even an occasional lamb at birth are reptiles.

Lieut.-Colonel L. M. Davies spoke as one to whom evolution is a fact yet to be proved, and pointed out the enormous differences between a bird's feather and any reptilian dermal structures. He asked how such things could happen as a result of explosive evolution. It was pointed out that 'explosive' is a word implying comparative rather than absolute speed of evolution, and that in any case the history of the birds is very badly known. Other speakers discussed giantism in various aspects, and a case of genetically controlled hyperpituitarism was mentioned. T. S. W.

SURVEYS OF UNDER-DEVELOPED AREAS

THE Duke of Edinburgh referred in his presidential address at the British Association to the various shortages which the world is now facing and which are "partly due to the huge inevitable waste of war and its consequences, and partly to the lack of any comprehensive survey of the world's resources and requirements". "It is only," the Duke continued, "by an accurate knowledge of the world's resources that we can foresee the scope and magnitude of the future problems which science and technology have to meet and which only they can solve." For a whole day, on August 14, an inter-section discussion was concerned with the need for the assessment of the resources of those areas that seem to the rest of the world to be undeveloped or under-developed and about which extravagant claims are often made. At the end of the day one of the speakers commented that, from the dozen or so papers read, one thing stood out most clearly—namely, that as scientific men, all recognized the need for more facts. Especially was there a need for the establishment of the facts by preliminary surveys. To make haste slowly was the speediest, as well as the surest, way of developing areas for the benefit both of their inhabitants and of mankind generally.

The importance accorded by scientific workers to the problems of the economic development of the under-developed parts of the world was shown by the number of Sections collaborating—E (Geography), C (Geology), D (Zoology), K (Botany), M (Agriculture) and F (Economics)—and by the size of the audience throughout the morning session. The problem of these areas has been posed by the politicians, notably by President Truman in Point Four of his address to Congress in 1949: "We must embark on a bold new program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of underdeveloped areas". But it falls to scientific workers to show just how these benefits are to be brought to such regions, and the discussion made it clear that there are no short cuts and no easy solutions, and that a tremendous diversity of conditions must be encountered. Prof. L. Dudley Stamp, who opened the discussion, claimed that the huge losses incurred in the Tanganyikan groundnut and the Gambian poultry schemes showed convincingly that, apart from any possible political or financial mismanagement, there is at present inadequate knowledge on which to base development schemes in underdeveloped lands, especially in the tropics.

Prof. Stamp explained the purpose and organization of the World Land Use Survey, of which he is director of the Old World Division. He elaborated the aims of this fact-finding survey—to record the existing use of the land and to attempt to ascertain the reasons why the land is used as it is—along lines similar to those of his article in *Nature* of June 23, p. 1010. The need for objectivity, he said, is paramount: if subjective judgments are introduced, the value of such a Survey will be greatly reduced. For these and other reasons, the Survey recommends that any map prepared should be, like the one-inch map, 'survey accurate', even though the final product covering the whole world will be only on the scale of one to one million. The land-use classification drawn up by a Commission of the International Geographical Union is designed to cover as many different categories of land use as possible in regions as diverse and as distant from one another as Thailand, northern Canada and tropical Africa. An essential prerequisite of development anywhere in the world, whether well known and intensively used or unknown and undeveloped, must be a record of the present position and the causes that lie behind it: in Prof. Stamp's phrase, there must first of all be a "synoptic, objective view".

Fifteen years ago the prospects of such a world survey would have seemed meagre indeed, and even to-day the financial problems are large and as yet unsolved. But, as several speakers pointed out, the use of air photographs in mapping now makes possible the covering of much of the world, including many of the under-developed areas. In the absence of Brigadier M. Hotine, the director of Colonial Surveys, Lieut.-Colonel G. J. Humphries described the comprehensive and ever-increasing range of the activities of that Directorate since its establishment in 1946, and discussed some of the difficulties encountered both at headquarters and in the Colonial territories. He explained the adoption of the scale of 1/50,000 as being the one that most nearly meets the requirements of most users of the maps. Contouring remains the chief bottle-neck; hence the issue of 'preliminary plots' in black-and-white only, and with hachuring to indicate certain relief features; but fully coloured, contoured maps will be available later once the immediate and pressing demands of the development plans of all British Colonies have been met. Later in the discussion, Mr. T. D. Weatherhead, director and general manager of Hunting Aerosurveys, Ltd., gave illustrations of how his company's photographs have helped agricultural and planning authorities and guided geologists in undertaking their field-work. He believed that the problem of speedy contouring can be overcome by the wider use of aids such as the airborne profile-recorder.

Two geographers spoke of land-use surveys with which they had been associated and thus illustrated both the potentialities and the problems of so vast a project as a world survey of land use. Dr. J. Wreford Watson, head of the Geographical Branch, Department of Mines and Technical Surveys, Canada, showed how geographers are employed by the

Canadian Government "to survey conditions as they are, ... geography being regarded as a factual not a remedial aid to government", and described the regional surveys made in different parts of Canada. He pointed out that the size of Canada makes a field-by-field survey impossible and compels the use of the sampling method, larger areas being interpreted by detailed studies of typical samples. In his view the success of the World Land Use Survey will depend on its inclusive categories and its generalized scale. Mr. R. M. Prothero, of University College, Ibadan, described some of the problems of land-use mapping in the forest areas of southern Nigeria, stressing the lack of map-cover in many tropical regions and the difficulties in interpreting air photographs—such as the problem of the identification of cacao, especially in a country with thousands of very small farms. Nevertheless, his preliminary investigations in an area north of Ibadan gave some interesting information that is so often impossible to come by in the tropics, namely, data concerning, for example, bush fallows and the amount of land available for cultivation.

Most of the fields of science concerned in the carrying out of surveys were represented in the discussion, though there was no forestry contribution — an unfortunate omission in view of the breadth of view so characteristic of forestry departments and of individual foresters in many under-developed areas. Prof. T. N. George, of Glasgow, spoke of the geologist's interest in the problems of development. He described how in the past a high proportion of the time of geological surveys was taken up by the investigation of mineral deposits of possible commercial significance, and showed how the question of development still turns largely upon the nature of the economic conditions prevalent at any particular time. The contribution of the soil scientist was emphasized by several speakers, and especially by Dr. Herbert Greene, adviser on tropical soils at Rothamsted Experimental Station. He recognized four factors that have made soil survey easier and more significant during the past twenty-five years: the use of air photography; the concept of soil associations fashioned in East Africa by the late Geoffrey Milne and his colleagues; the discovery of insecticides and drugs that make possible the occupation of vast areas, especially in tropical lowlands, that were not previously available; and the principle of what he termed 'beneficial use', whereby the communal interest and the sense of partnership were seen to matter more than any individual claims to rights in land or water. At the same time, he directed attention to the problems in certain under-developed areas where nationalism seeks the fruits of technology but rejects the foreign technician. He was convinced that the British are right in their policy of encouraging the nationals of such areas to take an active and responsible share in the work of development: thus, and only thus, will they appreciate that the limitations on development are imposed not by the whim of an alien power but by the natural conditions.

"A Zoological Contribution" was the title of Dr. E. B. Worthington's paper, read for him in his absence; but Dr. Worthington speaks as much more than a zoologist, because of his outstanding work for all the sciences in Africa and in virtue of his position as secretary-general of the Scientific Council for Africa South of the Sahara established last year. This Council, an international body, is, he suggested, rightly conceived, since science can know no frontiers, and it would take great notice of this discussion by British scientific men of the problems of under-developed areas. He pointed out how considerable is the scientific potential of Africa to-day, especially on the biological side, largely as a result of wise spending by the metropolitan and Colonial governments and through the establishment of the Colonial university colleges and research institutions in British and non-British territories. The tsetse fly has so far saved much of Africa from disorderly development—in contrast to parts of the Far East and south-east Asia—and in his view there is still time to bring science to bear upon African problems, though he foresaw serious difficulties arising from the rapid growth of population in certain areas.

Most time was not unnaturally devoted to the huge under-developed parts of Africa, but several speakers besides Dr. Watson directed attention to other areas. Miss A. G. Donnithorne spoke of a rather different type of survey, that of the economist. She dealt with the Far East, citing in particular the work done in China by the selection of samples by Prof. Buck and his associates. Dr. C. F. Hickling, fisheries adviser to the Secretary of State for the Colonies, discussed fisheries in all parts of the world and showed that fisheries often represent undeveloped food supplies even in countries that are otherwise well developed: many tropical waters are not merely undeveloped but quite unexplored. The Colonial Office is establishing fisheries research stations and fisheries departments which will concentrate on the development of existing fisheries and the improvement of methods of catching and preserving. Care is being taken to avoid the heavily capitalized unit and to enlist, wherever possible, the co-operation of the local fisher-folk. Sir Geoffrey Evans, of the Royal Botanic Gardens, Kew, focused attention on the land settlement problems of those areas round the Caribbean that he knows so well, and where it is hoped that homes may be created in British Guiana and British Honduras for some of the growing populations of the West Indian islands. He stressed the need for preliminary surveys, especially of soils, before the possibility of rail or road construction (essential for any real development) can be entertained. One of the world's basic problems to-day is, in his opinion, that of food supplies in relation to a rapidly increasing population. Contrary to a commonly held view, there are not large areas of first-class land in the virgin tropics capable of producing food: there is, he claimed, far more second-class and marginal land.

It must be recognized, moreover, that not all the under-developed lands are uninhabited, and this in itself gives rise to a whole series of problems. Dr. Greene dealt with the difficulties of partnership, and the several references made by different speakers to human values and relationships made it clear that scientific workers fully recognize their great significance. No speaker put this better than Dr. A. S. Thomas, principal scientific officer of the Nature Conservancy, with a wide experience of tropical Africa. "Development," he said, "is not merely a matter of production and exports, or even of hospitals and schools, but of human development and human happiness. We must preserve this happiness of the people until we know more, not only about their crops, but about them also." Here Dr. Thomas was bringing together the concern of all the sciences. He showed, too, how false are many of the common generalizations about the tropics, and how misleading can be the experience of temperate lands when

applied to tropical conditions. We are still grossly ignorant of the interaction of all the factors that control plant growth near the equator, and this information can, he claimed, be gathered in only one way—by the slow, careful, even laborious method of the preliminary, detailed survey. "The more revolutionary the cultural methods to be used," he warned, "the greater the need for pilot schemes and for working in small units."

Statements like these do not appeal to the politician or to the official who wants quick returns and speedy and convincing results. But they are typical of the caution and realism of the scientific worker and, significantly, were endorsed by all those taking part in the discussion. They are clearly the convictions of the organizers of the World Land Use Survey, which will provide an objective record of the existing facts of land use and which is intended as a foundation for schemes of improvement and development in all parts of the world. It is to be hoped that a small part at least of the many millions at present available for development and welfare schemes will be directed towards this Survey in different countries, so that it may speedily be established on a permanent basis. Here is a project in which all the sciences are interested and all men of science can, and should, co-operate: and it cannot fail to make a real and substantial contribution to the scientific study of under-developed, as well as other, areas and also to the progress and happiness of those who are sometimes termed the world's under-privileged peoples.

ROBERT W. STEEL

NEWS and VIEWS

Sir Arthur Fleming, C.B.E.

AFTER fifty years of distinguished service to the causes of industrial research and the education and training of industrial personnel, Sir Arthur Fleming has resigned his post as director of research and education to the Metropolitan-Vickers Electrical Co., Ltd., although he will remain a director of the firm; he has also agreed to assume general direction of research and education for the group of electrical firms known as A.E.I., Ltd. The Research Laboratories at Trafford Park, Manchester, which Sir Arthur was responsible for creating and developing, have produced outstanding contributions to scientific and technical knowledge and achievement over a very wide field, and have afforded unique opportunities to a long succession of investigators many of whom have attained eminence in their respective subjects. He will be most remembered, however, for the influence he has exerted on technical education in Great Britain. The number of apprentices and trainees of all grades for whom systematic training has been provided in the Metropolitan-Vickers works now totals more than ten thousand, and a glance through the register of them, published a short time ago, reveals the amazing extent to which these facilities have benefited the electrical industry as a whole, the government services and the educational institutions of the country; and have also provided trained personnel for almost every other country. The Metropolitan-Vickers training scheme acquired a world-wide reputation many years ago, and established a pattern which has been widely adopted.

Sir Arthur's activities have not been confined to Metropolitan-Vickers. His knowledge and experience have been placed unsparingly at the disposal of numerous societies, the universities and government establishments, and, in particular, he has held the positions of president of the Institution of Electrical Engineers and of both the Engineering and Education Sections of the British Association. He has been the recipient of many honours, including the Faraday Medal of the Institution of Electrical Engineers and the Hawksley Medal of the Institution of Mechanical Engineers; he was granted the degree of D.Eng. *honoris causa* by the University of Liverpool; was appointed O.B.E. in 1918 and C.B.E. in 1920 for his work on submarine detection, and in 1945 was knighted for his outstanding services to education. Sir Arthur retains remarkable physical and mental vitality, and it is to be hoped that he will long continue to give industry and education the benefit of his far-sightedness and intense enthusiasm.

Dr. C. Dannatt, O.B.E.

DR. C. DANNATT, who succeeds Sir Arthur Fleming at Manchester, has had some thirty years service with the Metropolitan-Vickers Electrical Co. After military service in the First World War, he graduated in electrical engineering from the University of Durham and went to Metropolitan-Vickers in 1921 as a college apprentice. He joined the Research Department in 1922 and over many years has built up a very close association between the Research and Engineering Departments of the Company on design and related matters. He is the author of many papers and articles on electrical engineering subjects, and in 1936 was awarded the D.Sc. degree of Durham. In 1940 Dr. Dannatt was appointed to the chair of electrical engineering in the University of Birmingham; but due to war-time commitments he filled it only on a part-time basis. Before and during the Second World War he was actively associated with the Admiralty in the application of remote control to gunnery, being one of the original members of the Admiralty Remote Power Control Committee, and for this work he received the O.B.E. in 1943. In 1944 he vacated his university chair and rejoined Metropolitan-Vickers, this time on the electrical engineering side, and became in 1947 chief electrical engineer of the Company with a seat on the Board. Dr. Dannatt therefore brings to his new post a very broad understanding of the requirements of a large manufacturing organization in industrial research and also in the recruitment and training of technical staff. Coupled with his additional appointment as assistant managing director of the Company, there is every reason to believe that under his guidance the forward-looking policy of the Metropolitan-Vickers Co. in these vital activities will be fully maintained.

Institute of Biology: Mr. D. J. B. Copp

MR. D. J. B. COPP has been appointed secretary of the Institute of Biology as from October 1. Mr. Copp is a graduate of University College, Southampton, where his studies were interrupted by the War, when he was engaged on radar research at the Admiralty Signals Establishment (Extension), Witley. In 1947 he was appointed assistant secretary of the

British Association and in that capacity he has become well known to a large number of men of science who have greatly appreciated his unobtrusive but active and efficient work in connexion with the five post-war meetings of the Association and with the Association's publications, conferences, press relations, etc. He has taken a special interest in the student membership of the Association and in dealing with applications from school science societies and clubs for assistance in drawing up their programmes. The young Institute of Biology is fortunate to have obtained as its principal permanent official an energetic officer of proved administrative ability.

Physical Society Medal Awards : Dr. A. B. Wood

The Council of the Physical Society has awarded the Duddell Medal for 1951 to Dr. A. B. Wood for his work on the design of instruments for use in work on under-water acoustics. One of the main investigations which Dr. Wood has carried out is the echo depth-recorder, in which magnetostriction oscillators are used for transmitting powerful high-frequency sound signals and to receive weak returning signals. These depth recorders are fitted in many important ships throughout the world, and are adapted to give an automatic record of the contour of the sea-bed over a very large range of depths. The depth recorder was primarily designed for hydrographic surveying and is also used for navigation, the location of wrecks and shoals of fish, and to indicate the silting up of harbours. Dr. Wood was largely responsible for the development of the acoustic mine and for appreciating the difficulties which had to be overcome in ensuring that the explosion of one mine should not actuate the rest of the mine-field. The piezo-electric pressure gauge and cathode-ray oscillograph designed by Dr. Wood are used in investigations of the pressure-time curve of under-water explosions. The details of this work have formed the basis of a large volume of experimental and theoretical research on the damaging effect on ships of under-water explosions.

Dr. J. H. E. Griffiths

The Council of the Physical Society has awarded the Charles Vernon Boys Prize for 1951 to Dr. J. H. E. Griffiths, of the Department of Experimental Philosophy, University of Oxford, for his work on ferromagnetic resonance. In carrying out measurements on the permeability of ferromagnetic materials at centimetre wave-lengths, Dr. Griffiths found that the high-frequency resonance of the metal increased to a maximum with increasing magnetic field and then decreased. This suggested that the effect must be due to ferromagnetic resonance of a nature similar to nuclear resonance ; since electron spins precess according to the combined effect of their internal and external fields, this ferromagnetic resonance is capable of becoming a new tool for the investigation of magnetic materials.

Nuffield Foundation Grant to the Royal Anthropological Institute

The symposium on Blood Groups and Anthropology on March 17, 1951, organized by the Royal Anthropological Institute (see *Nature*, May 5, p. 705), served to focus attention on the need for co-ordination of the work now being done in a relatively new field of research. Arising from this symposium, the Institute appointed a Blood Group Committee, and a grant of £14,000 has been made by the Nuffield Foundation to establish a research centre which will be known as the Nuffield Blood Group Centre of the Royal Anthropological Institute. The new Centre will classify the large and rapidly growing body of data on the distribution of the human blood groups throughout the world, assess it statistically and make the results available to anthropologists and other research workers. It will also carry out and stimulate work in Great Britain and abroad where this is desirable in order to follow important clues or to fill gaps in the world picture, and in particular will continue work now in progress on the classification of British blood donors. The centre will be at the Royal Anthropological Institute, 21 Bedford Square, W.C.1, and it is hoped that it will be in operation on January 1, 1952. It will greatly facilitate the work if persons publishing or having published papers on the frequencies of blood groups and other genetical factors in particular populations will send reprints to the Centre. Pending the appointment of a director, reprints will be acknowledged by the Secretary of the Institute.

New Forestry College for Cyprus

A new Forestry College for Cyprus was opened by the Acting Governor (Mr. John Fletcher-Cooke) on September 27. The College, which is situated at Prodhromos, 4,500 ft. up in the Troodos Mountains, is to provide training for forest guards and foresters. In addition to studies in the basic sciences, botany, geology, soil science, meteorology and ecology, the syllabus will include such subjects as sylviculture, crop mensuration, yield regulation, forest engineering and surveying, the utilization and preservation of timber, and protection of forests against disease. Each of the two courses for guards and foresters will last one year. Fifteen places out of a total of thirty-six are reserved for students from countries outside Cyprus, and it is expected that students from neighbouring countries will receive their training there. The director of the College is Mr. R. J. Streets, who was released by the Forestry Commission of Great Britain to take up the post ; Mr. Streets was formerly in charge of the Forester Training School, Lindford Hall, Thetford, Norfolk.

Institute of Geodesy, Photogrammetry and Cartography, Columbus, Ohio

The recent establishment of an Institute of Geodesy, Photogrammetry and Cartography in the Ohio State University, Columbus, by the board of trustees, has recently been announced. This embraces an executive board and several committees dealing with research, professional development, etc. An advisory committee of international composition has been appointed by the University administration. In association with the Institute is offered an integrated programme of undergraduate and graduate instruction. The undergraduate curriculum, which covers four years and leads to a B.Sc. degree (with a 'major' in geo-sciences), comprises a broad range of subjects in well-chosen proportion. These, in order of magnitude, are mathematics (a necessary foundation), physics, geology, chemistry, astronomy, etc. ; and in the fourth year, geodesy, photogrammetry and electronics. Languages and the humanities have a quarter share of the total programme. The course, indeed, can have a wide cultural value as well as providing a sure foundation for later special study. For this there are graduate courses of instruction suited to individual needs and capacities. Though

geodesy is a most ancient science, its applications are much widened by present-century developments, peaceful and otherwise. The scientific surveyor of the second half of the twentieth century requires a wide basic training; and the problem of its provision awaits solution. The trustees of the Ohio State University deserve credit for their constructive effort, and the progress of the new Institute and school will be watched with much interest and may perhaps stimulate similar action elsewhere.

Memoranda of the Indian Science Congress Association

Four memoranda prepared by the Indian Science Congress Association, at the request of the United Nations Educational, Scientific and Cultural Organization, have been issued under the title "'Scicong' Memoranda for Unesco" (pp. 59. Calcutta 16: the Association, 1951). The first of these is a review of the energy and power resources of India, prepared with reference to the Unesco discussion theme for 1950, "World Energy and Power Resources", to which a bibliography is appended. The second memorandum outlines the activities of some typical science clubs in India; these include the students' scientific societies in connexion with universities and like institutions, and some suggestions are made for the further development of such societies, including the use of educational and documentary scientific films and of exhibition boxes of scientific interest. The third memorandum, on the popularization of science through books, gives a fairly comprehensive picture of the position of publication and of science writing in India. Although a start has been made in the popularization of science in India in this way, science writing is unlikely to develop into a professional occupation for some years. The fourth memorandum, on international collaboration between existing associations for the advancement of science, reviews briefly the history of the Indian Science Congress Association and discusses the desirability of forming an international federation of associations for the advancement of science. One reason for advocating the formation of such a federation is that it might deal more satisfactorily with questions relating to freedom of scientific inquiry, and the dangers involved by secrecy in science, than the Committee of Social Relations of the International Council of Scientific Unions has done. The value of that Council for purely academic and scientific problems is fully recognized; but the Indian Science Congress Association would welcome the formation of a federation to encourage symposia and discussions of scientific problems of wide social and international import and the publication of an international journal covering such matters.

Survey of the Ticks of South Africa

The *Onderstepoort Journal*, created in 1933 to replace and continue the annual reports of the director of veterinary services and animal industry of the Department of Agriculture, Union of South Africa, has earned a permanent place in all libraries that cater for readers interested in the welfare of domesticated animals, the diseases that afflict them and the organisms that cause these diseases. The papers it publishes reflect the wide scope of the work done at the Onderstepoort Veterinary Research Station, from which the *Journal* is published. A feature of this work has always been its broadly biological outlook. Typical of this is the survey of the ticks of South Africa, which has been undertaken as part of a zoological survey of the Union. Ticks collected all over the Union by government veterinary officers have been sent to the Onderstepoort Laboratory, and the material thus collected is being studied by Miss Gertrud Theiler. In Part 1 of her report (*Ond. J.*, **23**, 217; 1948 [*sic*]) she comments on the difficulties created by the methods adopted for the collection of the ticks. She has, however, been able to draw certain conclusions from her studies. The species discussed by Miss Theiler are as follows: in Part 1, *Amblyomma hebræum*, the vector of 'heartwater'; in Parts 2–3 (*Ond. J.*, **22**, 255; 1949 [*sic*]), *Boophilus decoloratus*, the blue tick, and *Rhipicephalus appendiculatus*, the brown tick; and in Parts 4–6 (*Ond. J.*, **24**, 1; 1950), *Rhipicephalus capensis*, *R. evertsi*, and *Ixodes pilosus* and *I. rubicundus*. Each of the articles is accompanied by maps which show the localities in which each of the ticks discussed was present, together with information about the nature of the districts concerned and about the relevant climatic factors.

Prehistoric Sites on the North Cornish Coast

A very useful article entitled "Prehistoric Sites on the North Cornish Coast between Newquay and Perranporth", by Joan R. Harding (*Antiquaries J.*, **30**, July–October 1950), deals with a coastal area of Cornwall which is a little more restricted than is indicated by the title and covers the coast from Kelsey Head to the Penhole Sands. At the former site Mesolithic and Iron Age finds have been made, and at the latter relics of the Mesolithic and Bronze Ages have been discovered. Judging from the illustrations, the Mesolithic finds recall those made farther north at Constantine Bay near Padstow. Culturally, the flint industries are undoubtedly Mesolithic, though in time they may well be later and even overlap with the early metal age. Miss Harding is to be congratulated on bringing forward some very interesting finds.

Scottish Postgraduate Agricultural Scholarships

The Department of Agriculture for Scotland has recently awarded postgraduate agricultural scholarships, commencing this year, to the following: *Husbandry*, N. H. Cuthbert (Glasgow), dairy husbandry at the University of Reading; A. F. Gristwood (Edinburgh), poultry husbandry at the University of Edinburgh; P. C. Harper (Aberdeen), rural science at the University of Edinburgh; A. M. MacNair (Glasgow), agriculture at the University of Cambridge; I. S. Robertson (Edinburgh), agriculture at the University of Cambridge; T. Webster (Glasgow), agricultural science at the University College of Wales, Aberystwyth; *Agricultural Economics*, H. C. Currie (Edinburgh), agricultural economics at the Agricultural Economics Research Institute, Oxford. Three current awards have been extended for a further period of study as follows: *Husbandry*, A. O. Ballantyne (Glasgow), Ph.D. degree at the University of Edinburgh; H. G. Livingston (Aberdeen), dairy husbandry at the University of Minnesota; *Statistics*, St. C. S. Taylor (Edinburgh), Ph.D. degree at the University of Edinburgh.

Erratum.—In the article "Britain's Scientific Shrines (6)" in *Nature* of September 15, p. 443, column 2, for "Dr. William Browning" read "Dr. William Brownrig".

SLOW-NEUTRON TERNARY FISSION OF URANIUM-235

By Prof. E. W. TITTERTON
Australian National University

THE liquid-drop model of the fission process[1] was used by Present[2] in 1941 to predict that fission into three charged fragments is dynamically possible. A mode of fission involving three charged fragments was observed by Alvarez in 1943 in the case of the slow-neutron fission of uranium-235. Since that date, there has been a considerable body of work on the subject[3].

Experiments using photographic plates have been made by Wollan *et al.*[4], Demers[5], Green and Livesey[6], Tsien *et al.*[7] and Marshall[8]. They indicate that in about one-third per cent of the cases the slow-neutron fission of uranium-235 gives rise, in addition to the two heavy fragments, to a long-range α-particle which is emitted at nearly 90° to the heavy fragments. In these experiments the number of events with long-range light fragments were few, being respectively 27, 6, 58, 30 and 80, and many of these were incomplete, the long track leaving the emulsion. Moreover, except in the cases of Demers and Marshall, the emulsions employed were insensitive to energetic protons.

During three years work at the Atomic Energy Research Establishment, Harwell, detailed experiments were carried out using Ilford C_2 and D_1 emulsions impregnated with a saturated solution of uranyl acetate and irradiated in slow-neutron fluxes in GLEEP and BEPO. These experiments had as their objective: (1) Determination of the possibility of proton emission at the instant of fission. (2) Investigation of possible negative proton emission as an alternative to the delayed neutron emission known to occur from certain fission products. (3) Study of the energy distribution, angular distribution and frequency of the α-particles known to be emitted. (4) Search for the emission of heavier nuclei. In particular, lithium-8, or boron-8, either of which would give rise to a 'hammer track'[9], or beryllium-8, which would give rise to two α-particles. Examples of beryllium-8 emission have been observed by Goward, Titterton and Wilkins[10] in the photofission of uranium and by Titterton[11] in the fast neutron fission of thorium-232. (5) Determination of the frequency of occurrence of fission into three equal fragments, one case of which was reported by Tsien *et al.*[7].

More than half a million fission tracks have been examined, about half in C_2 emulsions sensitive to protons up to an energy of 40 MeV. and half in D_1 emulsions which, under the conditions of the experiment, recorded α-particles well but protons only up to an energy of 2·5 MeV. More than a thousand cases of ternary fission were observed, and preliminary results were reported briefly at the 1950 Harwell Conference[12]. The main results may be summarized as follows:

(1) Protons associated with fission tracks were observed in the emulsions. Where these were of range greater than 20 μ (1·25 MeV.) it could be shown from the geometry of the event that the track was due to a proton knocked-on by one of the moving fission fragments. Such protons, therefore, were not associated with the fission process.

(2) Negative proton emission was not observed, and if it occurs at all, is an improbable process. An upper limit of 1 in 5×10^3 can be assigned to the probability of negative proton emission relative to delayed neutron emission from the fragments concerned. This is discussed in detail elsewhere[13].

(3) The long-range α-particles emitted in fission are found to have an energy distribution as shown in Fig. 1, which is based on 862 complete events. The most probable value of the energy is 15 MeV., but the distribution extends to a maximum value of 29 MeV. This maximum value is considerably greater than that given by early workers—Farwell *et al.*, 16 MeV.; Green and Livesey, 20 MeV.; Tsien *et al.*, 25 MeV.; Wollan *et al.*, 22 MeV.; Marshall, 26·5 MeV.; Allen and Dewan, 26 MeV. The angular distribution of the α-particles relative to the light fission fragment is shown in Fig. 2, and from its shape definitely precludes the possibility, suggested by Feather[14], that the α-emission might take place from one of the moving fission fragments, or the possibility that a (n,α) reaction is followed by fission. The observed maximum α-particle energy is consistent with the idea that the α-particle is left between the two heavy fragments and acquires its energy from their electrostatic fields. The angular distribution also supports the view that the α-particles, in most cases, are left at rest and acquire their energy by repulsion from the heavy fragments.

The energy released in this mode of fission was measured and, within the limits of the experimental errors, was found to be the same as for binary fission.

For three-particle events with α-particles in the energy range 5–30 MeV., the frequency of occurrence was found to be 1 event per 422 ± 50 binary fissions, a figure which compares with 1 in 505 ± 50 for the same energy-range found by Allen and Dewan[3] in the most recent counter experiment.

(4) In the present investigation, no instance of lithium-8, boron-8 or beryllium-8 emission has been observed. However, in agreement with other authors[6,7], short-range fragments, apparently associated with the fission instant, were observed. By plotting the frequency of occurrence of recoils along the fission track, it was shown that there is an excess of tracks in the central region over that to be

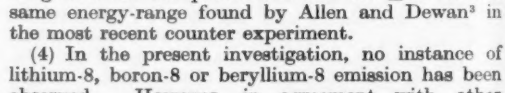

Fig. 1. Energy spectrum of the α-particles emitted in the slow-neutron ternary fission of uranium-235. The arrow indicates the energy of the most energetic particle observed
Ordinate: Number of particles (arbitrary units).
Abscissa: α-Particle energy in MeV.

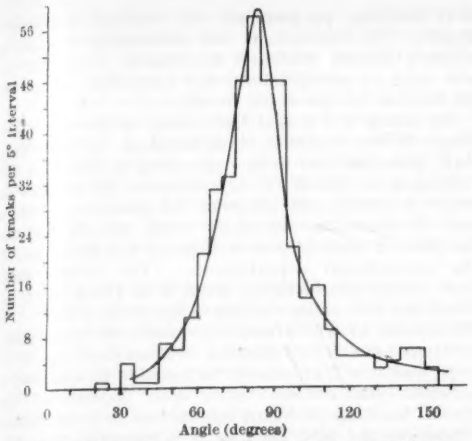

Fig. 2. Angle of emission of α-particle relative to the light fission fragment

Ordinate: Number of tracks per 5° interval.
Abscissa: Angle (degrees) measured from light fission fragment.

expected from the theory[16]. Moreover, work with desensitized emulsions showed that these tracks were still present when the emulsion was no longer recording α-particles. These experiments suggest that at least some of these short-range particles have a charge greater than 2, and tracks of this class were found with ranges up to 5 cm. of air[16], though the most probable value was observed to be ~ 1 cm. of air. After correction for random events caused by the chance superposition of fission tracks on the background of α-particles and protons (from the reaction $^{14}N np ^{14}C$) which are present in the emulsions, a frequency of occurrence for these events can be obtained. Three-particle fission, in which the light fragment has a range less than 20 μ, was observed at the rate of 1 event per 85 ± 10 binary fissions. This frequency is in agreement with that found by Green and Livesey and Tsien *et al.*, while the indication of fragments of Z greater than 2 is supported by recent counter experiments of Dewan and Allen[15].

(5) Although events comprised of three heavy fragments each of range greater than 5μ were observed in the emulsions, the geometry in all cases was compatible with their being formed by the collision of the fission fragments with silver and bromine nuclei in the heavy component of the emulsion. Moreover, the frequency of occurrence of these events was as predicted theoretically, assuming the interaction to be with the silver and bromine nuclei in the emulsion.

The experiments thus provide no evidence for fission into three approximately equal fragments as originally suggested by Present[2], and, in this respect, confirm the counter experiment of Roser and Hudson[17]. The event observed by Tsien *et al.*[7] in which a particle of mass ~ 32 was emitted must therefore be regarded with suspicion, since if it were true ternary fission some fifty such events should have been observed in the present experiments.

A detailed account of these experiments is in preparation and will be published at a later date. Thanks are due to the ten microscope observers who, in the course of their training, worked on the problem with great diligence, and especially to Miss E. M. Chellingworth, who helped with the analysis. I am grateful to Sir John Cockcroft, director, Atomic Energy Research Establishment, Harwell, for permission to publish these results.

[1] Bohr and Wheeler, *Phys. Rev.*, **56**, 426 (1939).
[2] Present, *Phys. Rev.*, **59**, 466 (1941).
[3] See summary given by Allen and Dewan, *Phys. Rev.*, **80**, 181 (1950).
[4] Wollan, Moak and Sawyer, *Phys. Rev.*, **72**, 447 (1947).
[5] Demers, *Phys. Rev.*, **70**, 974 (1946).
[6] Green and Livesey, *Phil. Trans.*, A, **241**, 323 (1948).
[7] Tsien, Ho, Chastel and Vigneron, *J. Phys.*, **8**, 165, 200 (1947).
[8] Marshall, *Phys. Rev.*, **75**, 1339 (1949).
[9] Franzinetti and Payne, *Nature*, **161**, 735 (1948). Titterton, *Phil. Mag.*, **42**, 113 (1951).
[10] Goward, Titterton and Wilkins, *Nature*, **164**, 661 (1949).
[11] Titterton, *Phys. Rev.* (in the press).
[12] Titterton, 1950 Harwell Conference Report, A.E.R.E., G/M.68, p. 79.
[13] Scott and Titterton, *Phil. Mag.*, **41**, 918 (1950).
[14] Feather, *Nature*, **159**, 607 (1947).
[15] Dewan and Allen, *Phys. Rev.*, **76**, 181 (A) (1949).
[16] Bohr, *Kgl. Danske Mat. Fysiske*, **18**, 8 (1948).
[17] Rosen and Hudson, *Phys. Rev.*, **78**, 533 (1950).

HIGHER EDUCATION IN BRITISH COLONIAL TERRITORIES

THE report on measures for the economic development of under-developed countries, which has recently been issued by the United Nations Department of Economic Affairs, stressed the difficulties which the low level of technology in such countries present to their development. One major obstacle to the advance of technology in such countries is the absence of an educational and administrative structure through which the producers can learn technology. Even where leaders of such a country at various levels—politicians, teachers, engineers, business leaders, trade unionists, religious leaders, journalists—all desire economic progress, understand what is required, and are willing to pay the price, much will still depend on education. The preparation, as recommended in this report, of a programme of education and research for a period such as five years, indicating not only objectives and proposed expenditure, but also what is required for agricultural extension services, for industrial training, and for the training of scientific workers and administrators, will make considerable demands, in both its preparation and execution, on the services of trained minds in such countries.

It is in the light of such ideas and plans that the significance of the work of the Inter-University Council for Higher Education in the Colonies is best assessed to-day. The third report of the Council*, which covers developments since September 1949, is thus appropriately considered against the background provided by the general survey over roughly the same period provided by the current report "The Colonial Territories, 1950–51"†, in which due weight is given to those political developments in self-government, for example, in the Gold Coast and Nigeria, which are making in themselves such demands on wise leadership by educated men and women. Those developments are summarized in Chapter 2 of the report, while the broad background of the educational situation is reviewed at the outset of Chapter 5, dealing with social services.

A feature of the report on "The Colonial Territories, 1950–51" is the evidence it supplies of the extent to

* Colonial Office. Inter-University Council for Higher Education in the Colonies. Third Report, 1949–50. (Colonial No. 273.) Pp. 24. (London: H.M. Stationery Office, 1951.) 9d. net.

† The Colonial Territories, 1950–51. Pp. ix+184. (London: H.M. Stationery Office, 1951.) 4s. 6d. net.

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which the people of these territories are learning to increase their own revenues through a better use of their natural resources, to meet the many and varied professional and technical needs of their own countries—in medical and health work, in industry and commerce as well as in social services of all kinds, including education—and to acquire the art of government through participation in their own political institutions. Much yet remains to be done. It is early yet to judge the success or otherwise of the constitutional developments in the Gold Coast, Nigeria and elsewhere, and both in health and in education there are serious shortages of staff which limit developments.

Nevertheless, the expansion of education, despite this and the other main limiting factor—finance—is again encouraging. In Malaya, the number of children at school increased by 50,000 during the year, and in Hong Kong, where seventy-three new schools were opened, by 30,000. In Kenya a scheme has been approved for raising the standard of African education at an estimated annual cost of £966,000 and a capital outlay of £1½ million over the next five years; Nyasaland has completed a survey of schools as a basis for a detailed programme of development to be completed in 1954; and in Tanganyika the 'ten-year plan' has been revised to provide primary schooling for a much larger number of African children. All territories, however, are still hampered by a serious shortage of teachers, although local training facilities and their output are increasing and there is a large recruitment of teachers from the United Kingdom each year. In Nigeria, for example, there are now eighty-eight teacher-training centres, including twenty-two for women, and two rural education centres for training teachers in rural science. Education for girls is a sphere in which expansion is particularly important.

The exchanges between the United States and the Colonial territories under the Fulbright scheme, and the research work and surveys briefly summarized in this report make special demands on the trained men and women coming from the Colonial universities. Travel grants have already been approved under the scheme to enable thirteen candidates from Malaya, Singapore, Nigeria, Kenya and Uganda to visit the United States for study and research. Meanwhile, progress in starting the various Colonial research stations and institutes is frequently hindered by the shortage of qualified staff.

There are now three universities and five university colleges in the British Colonial territories and the Anglo-Egyptian Sudan, and of these the University of Malaya was founded in October 1949, Makere College achieved university college status in November 1949, and in February 1950 the University College of the West Indies installed its first chancellor. These eight institutions, according to the third report of the Inter-University Council, have a total of 3,056 full-time students, the University of Malaya having 791 students in the current session and the University of Hong-Kong 715, while in the 1949–50 session there were a further 4,014 Colonial students in the United Kingdom, of whom 1,745 were in universities and university colleges. The total has increased to about 4,500 in the current session, the proportion of university to non-university students being probably the same. Since in 1951 the minimum requirements for entrance to United Kingdom universities are being raised, the number of Colonial students qualified for admission will decrease, and the need for developing the Colonial universities and colleges and completing their building programmes will become the more urgent. The situation is now developing in fact in which a Colonial student will normally proceed overseas only for postgraduate and specialist courses or for courses not provided locally.

Excluding the Royal University of Malta, where much of the teaching is undertaken by part-time staff, there are now in the remaining institutions 130 professors or heads of departments, 24 readers or senior lecturers, 144 lecturers, 90 assistant lecturers and 69 part-time specialist staff (chiefly in the faculties of medicine) as well as 15 full-time staff in the extra-mural departments. The student/staff ratio varies considerably, from 8 at Hong-Kong to 28 at the University College of the Gold Coast; but the extent to which academic staffs of high qualifications have been recruited induces the Council to hope that it will invariably be possible to maintain a generous staff/student ratio, both because of the special teaching problems inherent in Colonial higher education and also because it is essential that the staff should have adequate time for research. It is also encouraging to note that the proportion of locally born staff is rising.

A feature of the latest report on Colonial research was the evidence of the close association in the Colonies between research and higher education, and during the year the Inter-University Council learned from the Colonial Research Council that the mutual advantages of such an association are fully recognized. The main volume of research at the Colonial university institutions, however, is the private work of the academic staff, and already this output from some five hundred specialists represents a substantial addition to the resources of science and scholarship. Its value should be enhanced by the Fullright scheme already mentioned, for under that scheme American professors, research workers and students are enabled to work in Colonial institutions; during 1950–51 there were twelve such academic guests at the Universities of Malaya and Hong Kong and the University Colleges of the West Indies, Gold Coast, Ibadan, and Makere.

While progress in building schemes is extending the laboratory facilities which make the Colonial universities and colleges attractive as centres for research, and on the financial side these institutions are receiving generous local support from governments as well as from private organizations and individuals, appreciable progress is also reported in the libraries of all these institutions—in their holdings, administration, staffing and services. Again, particularly at the Colleges in the West Indies, the Gold Coast and Ibadan, extra-mural departments have been well developed, while all five university colleges are in a special relationship with the University of London to assist them to establish their standards and to devise the curricula and syllabuses for the degrees which they will award when strong enough to assume independent university status. Under this scheme, moreover, the University has made a separate arrangement with each of the colleges to meet the problem of entrance requirements and matriculation arising from the introduction by the Home Universities in 1951 of new minimum requirements for admission. The Council also welcomes the establishment in October 1949 of the Advisory Committee on Colonial Colleges of Arts, Science and Technology, and has held joint meetings with this advisory committee to discuss engineering education. Three such colleges have been established, in Nigeria, the Gold

Coast and Sierra Leone, and one of their most important functions will be to teach technical and commercial subjects up to professional level and to increase facilities for teacher training.

Technical education at the lower levels is, in fact, receiving increasing attention everywhere in the territories: in Uganda the main educational effort is towards schools of a less academic type; the junior technical schools in Malaya are filled to capacity, while a course in architecture has been added at the Technical College in Kuala Lumpur, and building for a new technical college is about to commence.

All these developments involve demands on the Colonial universities and university colleges and affect their work as well as the prospects for their students. But while the Inter-University Council has clearly been considering a wide range of problems as well as the factual developments recorded in this report, it scarcely touches on some fundamental issues concerning the position of university institutions in Colonial society. Satisfied that adequate academic standards of work have been attained and are likely to be maintained, the Council does indeed recognize that it is now becoming important to ensure that the most effective use is made of the services of students trained in such institutions, from the point of view of the students themselves and of their peoples. But it contents itself with expressing the hope that too high a proportion of the graduates will not be absorbed into government service, because of the importance of introducing some of this sure experience and trained ability into other sectors of society, such as journalism, commerce and industry.

The future of the Colonial universities does not depend solely on their ability to maintain high academic standards: it depends equally on their ability to provide the societies which they exist to serve with trained men and women who can meet the needs of these societies and fit happily into their way of life. If there is no place in such societies for the men and women coming from the new university institutions, no opportunity for the utilization of their technical or professional ability, and no adequate or satisfying cultural life, those institutions will themselves ultimately decay. The absorption of trained man- and woman-power into the Colonial life of to-day involves difficult and interesting problems, and the Inter-University Council could appropriately have used its annual report to discuss one or two such topics, particularly those bearing on the relationship between university education and secondary or primary education.

CURRENT TRENDS IN SOCIAL PSYCHOLOGY

At the recent Edinburgh meeting of the British Association, Section J (Psychology) devoted each of its five mornings to current trends in psychology, and in one session, "Current Trends in Social Psychology", four papers were presented which had many interlocking features. The first, by Dr. H. J. Eysenck, described researches into social attitudes. He held that popular newspaper polls of public opinion, the Gallup and similar polls, though interesting, are of little scientific value. Newspaper polls ask broad, general questions, and do not take sufficient account of the political affiliations of people questioned. Investigation into attitudes towards different issues of present-day importance show a great tendency for certain attitudes to cluster together in a manner characteristic of Radicals and Conservatives.

Dr. Eysenck propounded a distinction between what he calls "tough-minded" and "tender-minded" persons. (It is perhaps unfortunate that this distinction, well known in psychology since the late Prof. William James first used these terms, has been accepted by psychologists as meaning something different, but not entirely different, from Dr. Eysenck's new use of the term.) He contrasted the moral approach of the tender-minded, who are idealistic, ethical, religious and to whom the individual is sacrosanct, and the tough-minded, who believe in the inferiority of coloured people, Jews and women, and in the 'inevitability' of war. The working-class person, he said, is on the average very much more tough-minded and conservative than the average middle-class person. He described recent investigations into the organization of attitudes, their relation to political-party membership, age, sex, education, social class, and personality, and also into the effect upon the structure of attitudes of differences in culture-pattern.

The second paper, on "Personality Tests as Research Tools", by Dr. Hilde T. Himmelweit, considered 'objective' tests that require the subject to perform some task under standard conditions, the response to which can be objectively measured. Examples of these tests are of motor co-ordination, speed and accuracy of response, suggestibility, persistence, levels of aspiration and expressive movement. Though the behaviour involved in these may throw light on deeper mental levels, such tests do not tap these levels as specifically as projection tests do, and yet the results of objective tests are unaffected by the psychologist's subjective interpretation of the responses.

The use of batteries of objective tests makes possible the investigation of entirely new problems. One concerns the relationship between normal, neurotic and psychotic states. Kretschmer has maintained that these conditions differ from each other only quantitatively, not qualitatively, and can be viewed as lying along the same continuum with schizophrenia and manic-depressive psychosis. Eysenck, using a wide range of objective personality tests, has found that, on most tests, the patterning or inter-correlations of the test result was sufficiently similar in the normal and psychotic groups to support strongly Kretschmer's hypothesis. Objective tests are also useful in studying the effect upon the personality of leucotomy. Azenath Petrie has given tests to patients before and at stated intervals after this operation. The results enabled her to describe the characteristics of the post-leucotomy personality.

Objective tests will be used in a research, being carried out at the London School of Economics, into the differences in attitude to personality characteristics of young adolescents from different social classes. They will test the hypothesis proposed by Davis, of Chicago, that middle-class parents cherish higher aspirations for their children than working-class parents, that the child tends to introject the parents' demands and to react by having higher aspirations and being anxious regarding their attainment. It is proposed to find the extent to which middle-class children, compared with children from

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other classes, give significantly higher scores on tests of 'level of aspiration' and of anxiety.

The next speaker, Dr. A. T. M. Wilson, discussed "Social Changes in Structured Groups", a group being termed structured when it contains a manifest system of inter-related roles. The study of social processes in real (that is, not artificially created) situations, in terms of the psychological and social forces concerned, raises problems connected with the possibility of obtaining access to the group for the purpose of direct observation. There may be resistance or reluctance to proposals that the social investigator should be admitted to a 'reality situation', and this raises questions concerning the role of a participant observer in a community particularly susceptible to social change. If in a structured group need is felt for help in bringing about desired change, this need will provide one set of circumstances facilitating access by the investigator. A research worker, responding to a request for technical collaboration, in tackling a group problem, may assume a role the existence and independence of which are derived from its responsible professional character. The use of such roles may facilitate social change, since insight, derived from observations equally available to the group concerned and to the research worker, can be mutually communicated. The scope and limitations of such an approach were illustrated in detail from the work of one industrial organization which employs it.

Prof. T. H. Pear discussed "The Social Psychology of Everyday Life". This paper's title, borrowed with grateful acknowledgment, is that of a well-known article by Prof. Hadley Cantril, of Princeton University[1]. Written seventeen years ago, it urged that really important events in the lives of ordinary people had seldom been studied by psychologists.

To-day, one can report a considerable increase in the social significance of the subjects studied. The development of techniques for investigating attitudes and public opinion and for interviewing (for example, in vocational guidance, medicine and anthropology), the study of likenesses and differences in national characteristics and the effect of social factors upon test performances, the intensive study of patterns of culture and tensions between communities[2], all these events and more testify to a considerable change in the climate of opinion. The ordinary man in his social setting here and now is gradually if slowly becoming an object of scientific interest.

There are still important subjects which have received relatively little attention from social psychologists. Of these the most obvious are peace and war, since to-day almost all problems of planning are affected by the possibility of another war. Another neglected subject in Britain is social stratification. To the study of these subjects there certainly exist strong resistances; to discover and account for them is an interesting task for the social psychology of the future.

Prof. Pear's paper suggested that discovering the causes of this oversight is an interesting psychological project. Consider differences in classes, strata and *élites*. Much has been written about inferiority complexes[3], and our knowledge in this realm would be enriched by introspective accounts of how it feels to find oneself in such 'natural' situations of superiority or inferiority, and of the modifications of behaviour which one deliberately produces to adjust oneself. Partly conscious, partly unconscious factors may cause the widespread lack of interest among psychologists in problems of peace and war and of social stratification. It is time to realize frankly that in many people there are conscious reasons for not objecting to war. Unconscious reasons exist too; but they have had a good Press for the past three decades, and more research into the conscious reasons is needed. It is time for students of society to direct public attention less to the differences between peoples and much more to their resemblances, even if this decreases the 'novelty-rarity' value of their books and lectures.

During the meeting a demonstration was given of a film-gramophone technique, devised by Davide Boulting, C. E. M. Hansel and Prof. Pear, to investigate impressions of personality, vocation and social stratum from voice and facial appearance. While a voice spoke a prescribed passage designed to bring out geographical or social 'accents', pictured 'backgrounds', both physical and social, and faces were projected on the screen. In the experiments to be carried out, subjects will attempt to match these with the voices.

[1] *Psychol. Bull.*, 297 (1934).

[2] cf. Klineberg, Otto, "Tensions Affecting International Understanding", Bull. 62, Social Science Research Council, New York, 17 (1950).

[3] cf. Brachfield, Oliver, "Inferiority Feelings" (London: Routledge and Kegan Paul, 1951).

RECENT DEVELOPMENTS AND TECHNIQUES IN THE MAINTENANCE OF STANDARDS

A TWO-DAY symposium was held at the National Physical Laboratory during May 21 and 22 on "Recent Developments and Techniques in the Maintenance of Standards". Most of the standardizing laboratories of Europe, the Commonwealth and North America were represented, and delegates attended from many research organizations and industrial firms in Great Britain. Dr. E. C. Bullard, director of the Laboratory, in opening the symposium, remarked that it had every chance of being a successful occasion since there was no official business of any kind and no one need come to any conclusions. Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research, was among the audience and added his welcome to Dr. Bullard's.

Dr. D. G. Sopwith, superintendent of the Engineering Division of the Laboratory, took the chair for the first session, on "Primary Load Standards". The first paper was presented by Mr. B. L. Wilson, head of the Engineering Mechanics Section of the National Bureau of Standards, Washington. He gave a very interesting summary of the various dead-weight machines belonging to the Bureau and the types of devices calibrated in them. Dr. F. Aughtie (National Physical Laboratory) followed this with a paper on "The Primary Load Standard" in which he described the 50-ton dead-weight standard at the National Physical Laboratory and spoke of the adjustment of it to 'standard' gravity (980·665 cm./sec.), which was about to be undertaken. He described also the Laboratory's 5-ton standard for the calibration of small proving rings, and experiments with resistance-strain gauges on compression elements for loads greater than 50 tons.

The second session was concerned with "The Standard of Length", and Mr. F. H. Rolt, super-

intendent of the Metrology Division, National Physical Laboratory, was chairman. The first paper, "The Present State of a Lightwave Standard of Length", by Dr. E. Engelhard (Physikalisch-Technische Bundesanstalt, Brunswick), was presented for him by Mr. H. Barrell (National Physical Laboratory) in the form of a summary. It was pointed out that for more than twenty years, industrial end-gauges have been calibrated by reference to wave-lengths of light, and at the same time investigations have continued to find the best light sources. The pure mercury isotope $^{198}_{80}$Hg and the krypton isotopes $^{84}_{36}$Kr and $^{86}_{36}$Kr are now available for the excitation of an optical wave-length standard of great accuracy.

The method developed by Kösters at the Physikalisch-Technische Reichsanstalt (now the Physikalisch-Technische Bundesanstalt) for comparing wave-lengths of light with the metre has some interesting features, first in the use of a new type of beam divider, the 'interference double prism', secondly in the direct absolute interferometric measurement of an industrial 500-mm. end-gauge by means of Fizeau's fringes and the subsequent direct comparison of the end-gauge with an *Endstrich-meter* (a line metre which is also an end-gauge), and thirdly in the elimination of the refraction of air by means of a vacuum chamber.

The question whether a light-wave standard ought to be defined by wave-length in air or *in vacuo* was discussed. Kösters's method of eliminating the refraction of air removes the objection to a vacuum wave-length standard that in practice all measurements (for example, of block gauges) would be made in air.

The relative advantages of the mercury isotope and the krypton isotopes as sources of light were discussed, and the use of the krypton lamps at the temperature of freezing nitrogen was described. Experiments using xenon instead of krypton have so far not met with success. Various manifestations of line broadening and line displacement were discussed, and the essential conditions were specified for eliminating self-reversal and asymmetry of lines, which would lead to errors in the use of a light-wave standard.

It is not possible at present to realize an ideal light-wave standard. Lines emitted by an atomic beam would be ideal theoretically, but the intensity is too low. The question now is whether a mercury or a krypton isotope should be used to define the new standard of length.

Mr. Barrell then read his own paper, "The Interferometry of Length", in which he began by summarizing the history of the spectroscopic reference standard, the red line of cadmium, with the events leading to the present use of the mercury isotope $^{198}_{80}$Hg and the krypton isotopes $^{84}_{36}$Kr and $^{86}_{36}$Kr. He reviewed the progress of the investigations to select a wave-length to serve as the ultimate standard of length.

For the mercury isotopes, a simple form of electrodeless discharge lamp, free from certain broadening effects, has been designed at the National Bureau of Standards, Washington, by Meggers and Westfall. A series of well-distributed wave-length standards reproducible to $\pm$ 0·0001 A. has been provided from the isotope $^{198}_{80}$Hg; these standards have recently been used at the National Physical Laboratory for testing the accuracy of a new dispersion equation for air, valid over the range 2500–6500 A.

In Great Britain, various types of mercury-198 discharge lamps are now being produced commercially by the General Electric Company, Ltd. At present, the electrodeless lamp with 3 mm. argon is the best source of mercury-198 standards, but it has been established at the National Physical Laboratory that the argon produces slight asymmetrical broadening of the mercury-198 lines, the consequent red shift in the visible spectrum amounting to 0·0001 A. ($-0{\cdot}0003$ cm.$^{-1}$) per mm. of argon. The amount of argon in the lamps must therefore be controlled with 0·5 mm. mercury pressure to ensure reproducibility of wave-length within 1 part in 10^8.

The direct measurement of length by interferometry is now generally applied whenever the utmost precision and reliability are required. A specially designed form of Fizeau interferometer at the National Physical Laboratory will accept for measurement at one time up to twenty block gauges of size 2·5 cm. or less.

At the National Physical Laboratory, experiments in the measurement of distances of several metres are being made with electromagnetic waves of radio-frequency, using an interferometer of a modified Michelson form; a stabilized klystron source generates microwaves of frequency 24,000 Mc./s. (=1·25 cm.). The velocity of radio waves may be determined by reversing the process employed.

In answer to a question as to whether the refractive index of air was known to the accuracy demanded for interferometric work, Mr. Barrell said that wave-length measurements made in air can now be reduced to the vacuum condition (or vice versa) with a reliability of 3 parts in 10^8.

For the afternoon session, on "Standards of Radioactive Isotopes", Dr. B. W. Robinson, superintendent of the Physics Division, National Physical Laboratory, took the chair, and Mr. R. C. Hawkings (Atomic Energy Project, National Research Council of Canada, Chalk River, Ontario) read the first paper, prepared by himself, W. F. Merritt and J. H. Craven, on "The Maintenance of Radioactive Standards with a 4π Proportional Counter".

There is a need for instruments by which the absolute rates of disintegration of atoms can be directly measured, and there are many advantages in a particle counter having a solid angle of 4 steradians with the source. The workers at Chalk River have constructed a spherical 4π counter, which Mr. Hawkings described in detail. Each of the two sections consists of a hemispherical brass cathode having an anode connexion passing through a plastic insulator in the apex. The operation of the counter was described, with the type of amplifier made necessary by the wide distribution of pulse heights originating in it. The type of plateau obtained and the linearity up to 3×10^4 counts per second are very satisfactory.

The efficiency of the 4π counter is reduced to some extent by absorption losses in the source mount and self-absorption of the source itself. The losses in the mount, however, can be minimized by using the thinnest possible film; the correction is determined by placing an identical film over the source and then applying the reduction in count as a correction to the original count. Film-absorption correction factors for some commonly used nuclides were listed. The elimination of self-absorption losses was also discussed.

The relative regions of maximum efficiency using various counter gases were discussed, and the stability and reproducibility of the counter. The limiting factor

in attempts to increase accuracy now seems to be the technique of preparation of the source. Results obtained with the counter were compared with those derived from other methods, for example, defined solid angle and coincidence, for various nuclides.

The counter described, while sturdy and easily and quickly decontaminated and reassembled, is nevertheless a precision instrument which, when used in conjunction with the coincidence method of counting, has already proved invaluable in Canada and the United States.

The second paper of this session, by Mr. W. E. Perry (National Physical Laboratory), dealt with "Standardization of Radioactive Isotopes by Coincidence and γ-Ray Ionization Methods". Pure specimens of artificial radioactive isotopes in weighable quantities are not available; hence it has not been possible to prepare gravimetric standards as with radium. Standardization therefore requires activity measurements. At the National Physical Laboratory three methods have been used: β-particle counting by the small defined solid-angle method, the (β–γ) coincidence method and the γ-ray ionization method. Mr. Perry's paper was concerned with the last two.

In the (β–γ) coincidence method, the elementary formula for the disintegration-rate was derived, and the modifications to it to allow for various types of unwanted coincidences were discussed. The method requires two separate counting measurements and the measurement of the resolving time of the coincidence circuit, and the techniques of these were described. In particular, the introduction of an absorption screen, used to separate β- from γ-counts, is open to argument.

Results of the measurements of six cobalt-60 sources were given, in which the accumulated total error is thought to be at least ± 2 per cent.

The γ-ray ionization method was also briefly described. This is based on the relationship between ionization and the γ-ray energy: a value may be derived for the ionization produced by γ-rays from a given quantity of a radioactive isotope if certain fundamental constants can be assumed. Results were given of comparative measurements using both the coincidence method and the ionization method; the uncertainty in the ionization values is believed to be about ± 4 per cent and the differences between the ionization and coincidence values do not exceed this. Activity values for isotopes reported by various institutions in Great Britain reveal differences of the same size, and investigation must continue so that reliable standards may be provided and maintained.

After the two papers, Prof. J. Rotblat (St. Bartholomew's Hospital Medical College, London) opened a lively discussion on the method described by Mr. Hawkings of evaluating the correction for absorption in the source mount and on the effects of backscatter on the correction. There was some discussion also on the relative accuracy of the various counting methods; Mr. Hawkings considered that a great drawback of the coincidence method is the complexity of the electronic apparatus, which permits errors to arise.

Dr. Robinson was also in the chair for the first session on the following morning, when the subject was "Temperature". Dr. H. van Dijk (Kamerlingh Onnes Laboratory, University of Leyden) read a paper on "The Extension of the International Temperature Scale below the Oxygen Point", in which he summarized and discussed the most recent measurements of the thermodynamic temperature of the boiling point of hydrogen and helium, with the possibilities for interpolation between these fixed points and for extension of the scale below 4·2° K.

This was followed by a paper by Mr. C. R. Barber (National Physical Laboratory) on "Improvements in the Realization of the International Temperature Scale over the range −182·97° C. to 630·5° C.", an account of work in progress at the National Physical Laboratory. A platinum resistance thermometer and Smith bridge of new design were described; the noteworthy feature of the bridge is the form of the coils, which are specially wound to give freedom from mechanical strain. An account was also given of apparatus of new design for realizing the steam and sulphur points.

Dr. L. A. Sayce, superintendent of the Light Division, National Physical Laboratory, was chairman for the next session, which dealt with "The Standard of Luminance", and Dr. J. W. T. Walsh (National Physical Laboratory) presented the first paper, on "The Establishment of the Photometric Scale at the National Physical Laboratory", in which he described the primary standard of light, the preparation of sub-standards and working standards and the accuracy which can be assigned to the results of measurements made at the Laboratory on lamps submitted for standardization. M. J. Terrien (Bureau International des Poids et Mesures, Sèvres) then read a paper on "Co-ordination of the Photometric Units at the B.I.P.M.", in which he described the arrangements made for comparing the photometric units of the standardizing laboratories of France, Great Britain, United States, U.S.S.R., Germany and Japan, and the equipment of the photometric laboratory at Sèvres. It is estimated that the precision with which the B.I.P.M. comparisons indicates the value of the photometric standards throughout the world is, on an average, three or four parts in a thousand; an important source of error is variation in the lamps during transport.

For the final session, on "Standards of Frequency", the chair was taken by Mr. R. S. J. Spilsbury, superintendent of the Electricity Division, National Physical Laboratory. Dr. Erik Bergstrand (Kartverket, Stockholm) read a paper on "The Precision of Optical Methods for the Determination of the Velocity of Light", in which he made a critical survey of the methods and results of the main optical experiments and described in detail his own method in 1950 using a Kerr cell. He believes that the new value first obtained at the National Physical Laboratory by the cavity resonator method is not incompatible with the earlier results when these are given more realistic limits of error; the reason for earlier workers' almost universal arrival at lower values is perhaps that they were unconsciously influenced by the results of the elaborate experiments in 1931 and 1932 with the mile-long evacuated pipe. Dr. L. Essen (National Physical Laboratory) then described, in a paper on "The Measurement of Time, Frequency and Velocity", the recent improvements in the technique of frequency measurement, particularly at microwave frequencies. The measurement of velocity was one application of these techniques and another was likely to be the development of an atomic frequency standard. In the discussion which followed, Mr. J. H. Briggs (Telecommunications Research Establishment), Mr. H. M. Smith (Royal Observatory) and Mr. H. B. Law (Post Office Research Station) all supported the need for an atomic clock,

but Dr. L. Hartshorn (National Physical Laboratory) raised the question why we believe that atomic standards will be more nearly constant than other material standards. The question can only be answered by the agreement between different experiments and, as Dr. Bullard pointed out, agreement does not always indicate that the answer is correct.

The full proceedings of the symposium are to be published by H.M. Stationery Office in the course of the next few months. M. M. POSTGATE

OLD MOUNTAINS OF NEW GUINEA*

By L. EVELYN CHEESMAN

FOR all taxonomists interested in the west Pacific the fact that New Guinea possesses series of pre-Cambrian rock that have never been submerged has significance which cannot be over-stressed. Their existence indicates a solution of what otherwise would be inexplicable, namely, whence New Guinea derived its Oriental insect fauna and flora.

The huge island was raised from a drowned land-mass by the Miocene–Pliocene tectonic movements. So much is well known; but this furnishes no working hypothesis for botanists or for entomologists. The deductions which appear self-evident actually conflict with biological data; and, owing to their antiquity, it is to the insects and plants that we must turn for convincing evidence of land movements.

Land raised from the ocean bed during the Tertiary, its only subsequent continental connexion being periodically with Queensland and by sundry land bridges to Asia through the Philippines, might be expected to possess a flora and fauna basically Australian with an Oriental influence. Moreover, they should be discontinuous with many lacunæ in their totality. On the contrary, analyses of species belonging to any important group reveal an undoubted Oriental origin. There is an Australian element—more or less strong according to the group. There is a Malaysian influence attributable to a common Asiatic ancestry. There is a very rich peculiar neo-endemism suggesting isolation over a long period which makes Papuasia, that is, New Guinea with adjacent islands and archipelagoes, an extremely distinct zoological sub-region in geologically recent times. The flora and insect fauna are harmonious, their totalities show no serious lacunæ and no important group is unrepresented.

Papuasia therefore ranks with Australia and Asia in its continental full populations and not with neighbouring land-masses, Sumatra, Java and Borneo. These were also raised during the Tertiary, connected for a period with Asia and then isolated; but they possess a discontinuous flora and insect fauna.

Whence then did New Guinea receive its continental populations, since palæogeology apparently does not support the conclusions of botanists and entomologists?

We find on analysis of species that: (1) the average ratio of the older species groups is one-tenth Australian, three-tenths Asiatic, and six-tenths endemic; (2) the n rest genera allied to Papuasian endemic genera are found in Asia; (3) genera which are represented in both Malaysia and Papuasia are also found in India, Burma or China, often in all three countries. This points to a two-branched migration from the continent, which can be foreseen because there has been no land connexion between Malaysia and New Guinea subsequent to the Late Cretaceous. Otherwise the Sumatra tiger and monkeys and apes would have found their way to the New Guinea forests.

Before the War, Prof. Lam, of Leyden, was engaged on an analysis of the flora of Malaysia and Dutch New Guinea. He found that the proportionate representation was approximately the same as in the Insecta, and he agreed also with points (1), (2) and (3). Botanists have a decided advantage over entomologists in such matters because their material collected and determined is far more abundant. As in the Insecta there are no very old forms; the slight South American influence comes through Australia. There are many endemic genera but no endemic family.

The fact that there are two distinct geanticlines in New Guinea belonging to different periods sheds a most important light upon these questions of the distribution of species. The ancient geanticline was investigated by the Australian government geologist, R. C. Stanley, and his results were published in 1923. He directed attention to the existence of this ancient wrecked mountain system represented by relics, some of which have never been submerged, pre-Cambrian and Asiatic in origin. They are situated along the northern coast of New Guinea with the same alignment as the young Tertian central ranges which are Malaysian in origin. It is concluded that as the folding movements raised the central ranges the greater part of this old northern system was submerged. The series comprises south-west New Britain, which is still subsiding and has never been submerged, Finisterre Mountains, Torricelli Range, Oinake Massiv (Mount Bougainville), Cyclops Range which has never submerged, Japen Island, and Waigeu Island.

These form the margin of a drowned land which for my present purpose I have named Cyclopea. All these remnants are characterized by a strong tilting on their ocean side so that valley heads and gullies alone remain above the sea, and on their shoreward side there is a proportional elevation with much weathered cliffs of Cretaceous limestone containing Eocene Foraminifera. There has been land subsidence on a huge scale.

If we conceive this lost land-mass Cyclopea as having maintained connexion with Asia until the Early Pliocene, there we have ancient fully populated land from which the young land would be colonized as it rose from the ocean bed. This is acceptable to geologists and accords with the biological evidence. It is, in fact, the only working hypothesis satisfactory for taxonomists. The drift and overthrust of continents in that part of the globe does not directly concern biologists of New Guinea to-day, because Cretaceous New Guinea of yesterday, which with New Zealand formed the margin of Australia, was submerged, and the stupendous folding movements entirely altered all previous land formation.

Cyclopea has a different history; but whether palæogeologists decide that the land looped, festooned, arched, buckled, or streamed by New Guinea with the Solomon Islands in pursuit is immaterial to us. What we do insist is that they must postulate Cyclopea as a continuous land to Asia through the Moluccas and the Philippines prior to the Early Pliocene, otherwise any hypothesis will be rejected as untenable because of the testimony of botanists and entomologists.

* Substance of a paper read before the Royal Entomological Society on August 15.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Pure *All-trans* Vitamin A Acetate and the Assessment of Vitamin A Potency by Spectrophotometry

THE international unit of vitamin A activity corresponds with 0·3 μgm. of vitamin A alcohol or 0·345 μgm. of vitamin A acetate[1]. The International Standard Preparation is a solution of the *all-trans* acetate in cottonseed oil, and it serves a dual purpose as a biological and a spectrophotometric standard of reference. The properties of the acetate are therefore important.

The absorption spectra of many organic solutes vary to some extent in different solvents, even when there is no evidence of equilibria between isomeric forms. In the case of vitamin A such variations have been known to occur since 1935[2]; but they are second-order effects which have hitherto been largely ignored.

Advances in spectrophotometric technique, together with the advent of pure vitamin A and its esters, have made it possible to ascertain the solvent effects with considerable precision, and it is no longer appropriate to neglect them. Further, the spectrum of vitamin A alcohol (expressed in terms of molar extinction coefficient plotted against wave-length) is not necessarily identical with that shown by its esters in the same solvent. Granted that solvent effects occur, it is necessary to establish their magnitude in relation to the degree of accuracy which is both attainable and worth while. The present report is the result of work in five laboratories on synthetic samples (supplied by Dr. O. Isler of Hoffmann-La Roche, Basle). We are satisfied, however, that purified samples of *all-trans* vitamin A acetate obtained from natural products (and supplied by Dr. J. Matet of Alimentation Equilibree, Commentry) are identical with the synthetic acetate by chemical and physical tests[3,4].

PROPERTIES OF *All-trans* VITAMIN A
(Each figure is the mean of the results from the five laboratories)

Solvent	Alcohol $\lambda_{max.}$ (mμ)	Alcohol ($\varepsilon_{max.}$)	Acetate $\lambda_{max.}$ (mμ)	Acetate ($\varepsilon_{max.}$)
*Iso*propanol	324–326	52,300*	324–326	50,280†
Ethanol	324–325	52,480*	325–326	51,180
*Cyclo*hexane	326–327	49,760†	327–328	50,000†
Light petroleum (40°–60°)	324–326	52,000*	324–326	52,200*

Analysis of variance of the forty individual results indicates that: (1) the coefficient of variation between laboratories is 1·3; (2) the residual coefficient of variation of the one determination is 1·1; (3) the four means marked * are not significantly different; (4) the three means marked † are not significantly different; and (5) the remaining mean (51,180) falls between the other two groups and cannot confidently be regarded as a normal sampling variant of either. The two coefficients of variation given in (1) and (2) are normal—perhaps, indeed, rather below (that is, better than) normal. With the possible exception of the *cyclo*hexane result, the given mean values are generally consistent with those in the literature. Most published figures, however, favour a 1–2 per cent lower value for vitamin A esters in *cyclo*hexane than in *iso*propanol.

It follows from the above, and from the definition[1] of the International Unit of vitamin A so as to give a potency of $3{\cdot}\dot{3} \times 10^6$ I.U./gm. to the *alcohol*, that the appropriate factors for conversion of values at $\lambda_{max.}$ to I.U. per gram are most likely to be those given below:

CONVERSION FACTORS

Solvent	Vitamin A alcohol	Vitamin A acetate
*Iso*propanol	1,825	1,906
Ethanol	1,825	1,850
*Cyclo*hexane	1,906	
Light petroleum (40°–60°)	1,825	

The value of 1,906 for vitamin A acetate in *iso*propanol corresponds to an E(1 per cent, 1 cm.) value of 1,525, identical with the figure accepted by the Expert Committee on Biological Standardization of the World Health Organization[1]; and that body recommended the rounded-off factor 1,900 for practical purposes.

Now, in practice, vitamin A is often estimated in the form of the alcohol (the U.S. Pharmacopœia assay[5] stipulates saponification of vitamin A-containing oils, and chromatographic methods may involve saponification) for which the factor 1,900 would seem to be about 4 per cent too high if the final solvent is *iso*propanol. *Cyclo*hexane, on the other hand, would take the 1,900 factor under all conditions. In light petroleum $\varepsilon_{max.}$ is apparently identical with $\varepsilon_{max.}$ in *iso*propanol for the alcoholic form of the vitamin. This has certain practical advantages.

It should be emphasized that use of the conversion factors here accorded would not cut across the recommendation of the World Health Organization Committee, because the primary definition of the International Unit of activity is a weight of the vitamin, and the conversion factor is derivative. The presence of some neo-vitamin A (an isomer) in natural products is an additional complication. This point has been discussed by several authors[4,6] and will not be considered here.

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Simple Equipment to Estimate Radiocarbon

We have built a low-pressure argon-alcohol counting tube of very satisfactory performance for radioactive carbon dioxide (Fig. 1). The cathode is a brass cylinder of 16 mm. diameter, 0·5 mm. thickness and 80 mm. length. A wire is soldered to the cylinder and sealed into the glass with a thermo-setting plastic ('Araldit', Ciba). The anode, tungsten wire of 60 μ, is kept taut by a steel spring, and again sealed in with 'Araldit'. 'Pyrex' is used.

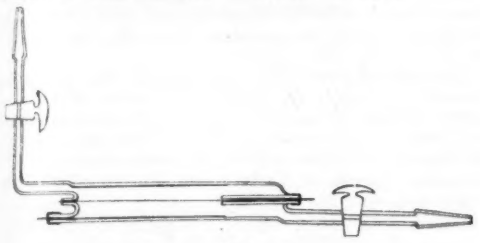

Fig. 1

The active carbon dioxide is generated in an all-glass vacuum line (Fig. 2) from barium carbonate and perchloric acid. The gas is dried by silica gel, and the carbon dioxide frozen out in a U-shaped capillary with liquid air. (No carbon dioxide is found to be held back by the silica gel.) After freezing the carbon dioxide, taps *A* and *B* are closed. Alcohol vapour is introduced into the filling line and the attached counting tube to a pressure of 15 mm. mercury. Now the liquid air is removed and tap *B* is opened again, until the desired pressure of carbon dioxide is attained. Finally, 3 cm. pressure argon is let in, and the counting tube is shut.

The length of the plateau is 250 volts with a gradient of 1–2 per cent/100 volts up to a carbon dioxide pressure of 5 cm. (Higher pressures could not be tested for want of a source of sufficiently high voltage; at carbon dioxide pressures of 1, 3, 5 cm. the plateau voltages were 1,150, 1,450, 1,800 volts.) The background of the counter, under 3 cm. of lead, is 28 min.$^{-1}$; it does not increase with time, that is, no radiocarbon is held back by the counter. Extreme differences in measured activities between repeated fillings, supposed to be identical, are 3 per cent. This reproducibility is at present limited only by the precision of the mercury manometer. The measured activity is strictly proportional to carbon dioxide pressure. The total time required to generate carbon dioxide and fill the counter is about two hours.

Loss of activity in air (through exchange) on heating barium carbonate, prepared as described below, for one hour, was found to be zero at 100°, 5 per cent at 300°, 11 per cent at 500°, and 15 per cent at 700° C. The rate of loss rapidly decreases with time: at 400° C., the losses after 1, 2, 4, 8 hr. were 8, 10, 11, 12 per cent respectively. In view of the fairly small losses at elevated temperatures, losses at room temperature are curiously high: 7, 9·5, 16 per cent after 7, 10, 18 days. Apparently a different mechanism operates at low temperature. At 100 per cent relative humidity, the losses at room temperature even reach values as high as 9·5, 16, 17, 17·5 per cent after 2, 6, 9, 11 days. Marked loss (3 per cent) has also been observed, after one hour, on stirring freshly precipitated barium carbonate with water.

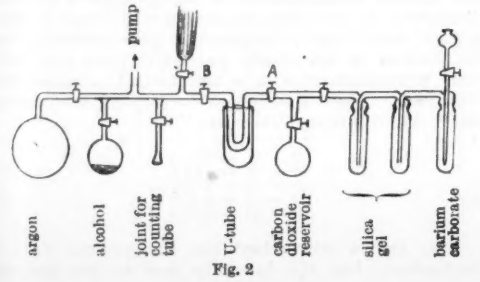

Fig. 2

It follows that no loss need be feared if samples are handled reasonably quickly in air; but kept in an atmosphere free from carbon dioxide for longer periods. In fact, no specific activity was lost at all in a cycle involving generation of carbon dioxide from barium carbonate, absorption in caustic potash, re-precipitation as barium carbonate—after addition of ammonium chloride to reduce alkalinity—with barium chloride, and drying in an oven in air at 140° C. for half an hour.

We thank Prof. K. Przibram and Prof. L. Ebert for their constant support, Dr. W. J. Arrol for the gift of radiocarbon, and our colleague Mr. H. Ebenberger for much friendly help.

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A New Radio Method for Measuring the Electron Density in the Solar Corona

Present estimates of the electron density in the solar corona are based on the measurements during an eclipse of the optical radiation which originates in the photosphere and is scattered in the corona[1]. These measurements and their interpretation present considerable difficulties, particularly when attempts are made to determine the electron density in the outermost layers of the corona[2,3]. In this communication a possible method of determining the electron density at different heights in the corona is suggested, which should allow the exploration of regions where the density is as low as 10^4 cm.$^{-3}$.

It can be shown that if the radiation from a remote source passes near a spherical transparent body in which the refractive index increases outwards, and the angular separation between the source and the centre of the sphere is less than a certain value, no radiation from the source can reach the observer. At larger separations, a deviation of its apparent position occurs. If, therefore, a radio star is situated in a direction near that of the sun, the radiation on certain frequencies may be 'occulted' even when the radio star is at a considerable angular distance from the visible limb. Using the existing data on coronal electron density, it can be shown that, for frequencies of 210, 81·5 and 38 Mc./s., the effective radii of the sun for occultation are of the order of $2{\cdot}9\,R_\odot$, $3{\cdot}6\,R_\odot$ and $4{\cdot}5\ R_\odot$ respectively, where $R_\odot$ is the photospheric radius. A precise determination of the values of the radii for a number of frequencies would allow the distribution of electron density with height to be deduced.

In order to perform this experiment, it would be necessary to observe the radio star when its direction is very near that of the sun; the solar radiation is then likely to mask the much weaker radiation from the star. It is, however, possible to reduce the effect of solar radiation, without reducing that from the star, by using an aerial arrangement which is relatively insensitive to sources subtending a comparatively large angle. It has been shown[4,5] that if an interferometer aerial were used with an aperture of 100–200 wave-lengths, the response from the sun would be reduced by about 98 per cent, although the response from a radio star would not be reduced at all. The presence of intense radiation from sunspots cannot unfortunately be eliminated so simply, owing to the smaller angular diameter of the sources of radiation; very much greater resolving powers would therefore be necessary.

It was noted that the intense radio star 05·01 in Taurus (R.A. $05^h\ 31^m\ 34^s$, decl. 22° 04′)[6] offered the possibility of carrying out this experiment, since with the existing aerial systems its intensity was sufficient to allow observations even in the presence of weak sunspots. A series of observations was carried out during June 1950 when the direction of the sun passed near the radio star (the minimum separation was about 4 $R_\odot$) and again in the corresponding period in 1951. During the latter observations, interferometers of aperture 205, 105 and 60 λ were used on frequencies of 210, 81·5 and 38 Mc./s. respectively.

Unfortunately, during both these experiments, sunspot radiation was abnormally intense, and no useful results were obtained. It is hoped to repeat the experiment in the future, when the sunspot activity is likely to decrease, possibly using aerials of greater resolving power. The co-ordinates of the radio star may then also be known with greater precision. The use of aerials of increased resolving power might also make it possible to use other less intense radio stars, and so increase the number of occasions on which the experiment could be carried out.

This work was carried out as part of a programme of radio research at the Cavendish Laboratory, supported by the Department of Scientific and Industrial Research, to which also one of us (K. E. M.) is indebted for a senior award. We are grateful to Mr. M. Ryle for suggesting the method.

K. E. Macein
F. G. Smith

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Cambridge. Aug. 3.

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Structure of Amorphous Aluminium Oxide Films

Aluminium generally is covered with an oxide layer which gives excellent protection against corrosion. Preston and Bircumshaw[1] and other workers, using the electron diffraction method, showed that the layers are not crystalline. Their electron diffraction photographs show two diffuse rings which have not yet been explained satisfactorily. In air and at temperatures below the transition into the crystalline phase, the oxide layer grows very slowly, and only up to about 100 A. in thickness. Consequently, as the layer is too thin for X-ray methods, electron diffraction techniques have to be used.

Diffuse electron diffraction rings can be interpreted in two different ways. Commonly they are explained by a size effect only. It is assumed that the material consists of normal crystals the grain size of which is exceedingly fine. Using this method, Belwe[2] evaluated the size of the individual crystals to be equal to about one elementary cell of γ-Al_2O_3. Belwe thinks that the diffuse rings found are due to the (220) and (440) reflexions, and the assumption is made that (220) and (440) are the strongest reflexions of Al_2O_3; other investigators, however, found (311) to be the strongest pattern.

The second possibility is to assume that the layer consists of totally disordered uniformly built molecular groups. It is then necessary to find, by trial and error, a molecular group such that the electron diffraction patterns which are calculated by the formula derived by Debye[3] and Ehrenfest[4] for the molecules of a gas:

$$I = \text{const.} \sum_i \sum_j \Phi_i \Phi_j \frac{\sin x}{x},$$

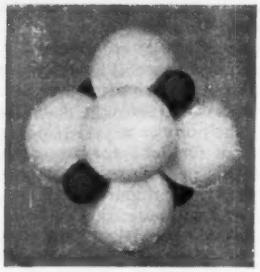
agree with the experiment. In that formula, I is the intensity, $\Phi = \dfrac{Z - F}{\sin^2 \theta/\lambda^2}$ is the atomic scattering factor for electrons, Z is the atomic number, F is the atomic scattering factor for X-rays, θ is the glancing angle, λ the wave-length and $x = 4\pi \cdot l_{ij} \dfrac{\sin \theta}{\lambda}$, with l_{ij} the distance between the atoms i and j in the particle. Debye[5] further derived a correction for X-ray diffraction in gases and amorphous substances which takes account of the mutual distances between all the atomic groups. He found this correction to be appreciable in the case of a substance of bi-atomic molecules. That correction should be considered whenever the above method is used. The first investigations using this second method were carried out by König[6]. For amorphous germanium König found that its diffraction patterns show that it consists of tetrahedral particles, a result which has been confirmed recently by X-ray diffraction methods.

In the present investigation, I have investigated amorphous aluminium oxide (Al_2O_3) by the same method. The oxide films were grown in air (400° C., 75 hr.). They were lifted free by a dilute mercuric chloride solution, washed and placed on specimen carriers with holes of 0·08 mm. diameter. The films were investigated with 40–60 kV. electrons in transmission. The photographs obtained were measured with a photometer, and the corresponding intensity curves were plotted. The maxima lay at $\sin \theta/\lambda = 0{\cdot}17$ and at 0·36.

After a number of unsuccessful attempts to find the atomic arrangements of the groups, a particle consisting of two Al_2O_3 molecules was found to give a good result (see photograph). This particle is an octahedron of six closely packed oxygen ions with four aluminium ions in a tetrahedral arrangement. The ionic distances involved correspond to those of the γ-Al_2O_3 lattice. They are:

O − O = 2·80 A.
O − O = 3·95 A.
O − Al = 1·72 A.
O − Al = 3·28 A.
Al − Al = 2·80 A.

The Debye correction[5] for the present case is negligible; but the intensity due to the inelastic



Model of the particle found, consisting of two Al_2O_3 molecules

scattering was taken into consideration, for which purpose the table of Bewilogua[7] was used. It should be stressed that the exact atomic arrangement of the particle found does not occur in the γ-Al_2O_3 lattice.

A detailed account of the present investigation and a discussion of the mechanism of the oxidation process will be published shortly. The present communication is published by permission of the South African Council for Scientific and Industrial Research.

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May 17.

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Estimation of the Approximate Ionization Constants of Inorganic Bases

Most of the common acidic compounds can be classed as derivatives of the hydrides :

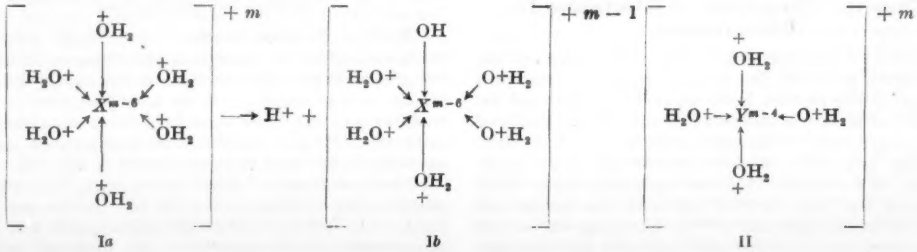
$$H_3O^+ \rightarrow H_2O + H^+ \quad \Delta G^0 = -1 \text{ kgm.cal.}$$
$$H_4N^+ \rightarrow H_3N + H^+ \quad \Delta G^0 = +13 \text{ kgm.cal.}$$
$$H_2O \rightarrow HO^- + H^+ \quad \Delta G^0 = +20 \text{ kgm.cal.}$$

Within any of these classes, large differences in the free energies of ionization ($\Delta G^0 = -RT \log_e K$ for the reaction $BH \rightarrow B^- + H^+$ in dilute aqueous solution at 25° C.) can usually be attributed[1,2] to the presence of charges in the near neighbourhood of the dissociating proton. Each charge on the atom next to the one bearing the dissociating proton will decrease the value of ΔG^0 by about 14 kgm.cal. if positive and will increase ΔG^0 by about 14 kgm.cal. if negative. The effect of a charge upon ΔG^0 is reduced when it is situated farther from the dissociating proton and $\pm 14Q/2^n$ kgm.cal. has to be added to ΔG^0 to account for the effect of a charge, where n is the number of atoms between the atom bearing the charge and the dissociating proton[2,3].

The ions of many inorganic bases are hydrated and may be regarded as acids[1,4]. For example, in aqueous solutions, and in many crystals as well, simple chromic salts contain the hydrated ion[5] $[Cr(H_2O)_6]^{3+}$. Brönsted and Volquartz[4] have shown that this ion is a moderately strong acid and they give a value of $\Delta G^0 = 5{\cdot}1$ (at 15° C.) for its ionization. This chromic ion (I*a*, $X = Cr$, $m = 3$) is a derivative of H_3O^+. There are three negative charges on the chromium atom, to which are attached five positive oxygen atoms besides the oxygen atom bearing the dissociating proton. When allowance is made for these charges, a value of $\Delta G^0 = -1 + (3 \times 14) - (5 \times 7) = 6$ is obtained. A correction should be made to this calculated figure for symmetry factors, since there are twelve equivalent protons in the acid (I*a*) and only one basic position in the base (I*b*); $RT \log_e 12/1 = 1{\cdot}5$ should be subtracted from the figure calculated above, bringing ΔG^0 to 4·5 kgm.cal., which is close to the observed value. It would be expected that any hydrated trivalent ion of formula (I) would have a ΔG^0 value in the neighbourhood of this calculated figure. Brönsted and Volquartz[4] measured the ionization constants of the trivalent ions of iron and aluminium, and their experimental figures give ΔG^0 equal to 2·9 and 6·5 respectively. In more recent determinations, ΔG^0 values for the ferric ion (4·0[6]; 3·5[7] and 3·2[8]) closer to the calculated figure have been obtained.

These values approximate to the calculated value, and it should be borne in mind that it is difficult to ensure that the experimental ΔG^0 value is a true measure of the free energy of ionization of one hydrated ion. The degree of hydration of the ion may change on ionization. Some metallic complexes condense to form ions containing more than one atom of the metal, while the measurements have to be carried out in the presence of several species of ions, and many ions, for example, chloride and sulphate, readily form complexes with certain metals. Brönsted and Volquartz[4] also measured the ionization constants of cobaltic ions in which some of the co-ordinated water was replaced by ammonia. The ammonium ion is so much less acidic than the H_3O^+ ion that only the hydrogen attached to the co-ordinated water molecules need be considered as dissociating. The calculated and observed values of ΔG^0 are as follows :

Ion	ΔG^0 kgm.cal. Found	Calculated
$[Co.4H_2O.2NH_3]^{3+}$	4·5	4·8
$[Co.3H_2O.3NH_3]^{3+}$	6·2	5·0
$[Co.2H_2O.4NH_3]^{3+}$	6·9	5·2
$[Co.H_2O.5NH_3]^{3+}$	7·5	5·6



The substitution of a divalent atom ($m = 2$) for a trivalent atom ($m = 3$) in (I) will increase ΔG^0 by 14–18·5 kgm.cal., in good agreement with ΔG^0 values of 17·3 and 18·2 found for the ionization of the hydrated calcium ion and barium ion respectively. These ΔG^0 values are calculated from the second basic dissociation constant of calcium hydroxide[9,10] and of barium hydroxide[10,11], which seem to be known with fair accuracy because recent determinations by different methods have given results in excellent agreement. The second basic dissociation constant for magnesium hydroxide gives ΔG^0 equal to 15·5 for the ionization of the hydrated magnesium ion[12], which is decidedly lower than the value of 18·5 just calculated for the hexahydrate (I, X = Mg, $m = 2$). In these calculations of ΔG^0 no allowance has been made for steric effects or for differences in the electronegativities of the atoms in the complexes. Some increase in the acidity of the magnesium ion might be due to steric effects in the hexahydrate of this small ion and to the fact that magnesium is more electronegative than calcium and barium[13].

All the ions mentioned above have been taken to be hexahydrates, as would be expected[14]. When the degree of hydration of a metallic ion is known, a rough estimate can now be made of its ΔG^0 value for ionization. Thus any monovalent ion X (I, $m = 1$) would be expected to give a value not very far from 32·5 kgm.cal. Alternatively, if ΔG^0 has been determined, it may be possible to suggest the degree of hydration. Thus, for the ion (II) with m equal to 1, the calculation of ΔG^0 gives $-1 + (3 \times 14) - (3 \times 7) - 1{\cdot}2 = 18{\cdot}8$, which is close to the value of 18·5 recently obtained[10] for the thallous ion.

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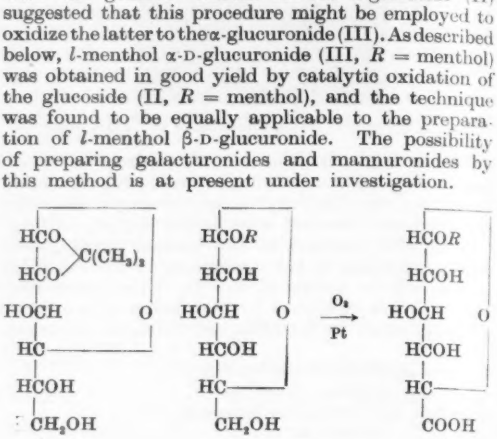
Catalytic Oxidation of Glucosides to Glucuronides

Studies of the structure and metabolism of the conjugated glucuronides formed from alcohols and phenols in the animal body have been hindered by the lack of a convenient method for the synthesis of these compounds. Controlled oxidation of the corresponding glucoside would appear to hold most promise as a method of glucuronide synthesis. This oxidation has been carried out with α-menthol and α- and β-methyl glucosides[1–4]. The reagents so far employed (bromine, hydrogen peroxide and nitrogen tetroxide) have, however, given very poor yields of the glucuronides.

Fernandez-Garcia *et al.*[5] have recently found that 1,2-*iso*propylidene glucose (I) is smoothly converted to the corresponding derivative of glucuronic acid when oxygen is passed through the solution in the presence of a platinum catalyst. Comparison of (I) with the general formula for an α-glucoside (II) suggested that this procedure might be employed to oxidize the latter to the α-glucuronide (III). As described below, *l*-menthol α-D-glucuronide (III, R = menthol) was obtained in good yield by catalytic oxidation of the glucoside (II, R = menthol), and the technique was found to be equally applicable to the preparation of *l*-menthol β-D-glucuronide. The possibility of preparing galacturonides and mannuronides by this method is at present under investigation.



l-Menthol α-D-glucuronide. 500 mgm. *l*-menthol α-D-glucoside and 100 mgm. platinum black were suspended in 80 ml. water and maintained at 65°. Oxygen was passed through the liquid, which was stirred and kept neutral to litmus by addition of dilute sodium bicarbonate solution. After 10 hr., one equivalent of alkali was consumed and no further change in *p*H occurred. All the glucoside had gone into solution at this stage. The catalyst was removed by filtration and the solution evaporated to a small volume. On acidifying to congo red with hydrochloric acid, the crude glucuronide, melting point 135–36°, separated in 31 per cent yield. Recrystallization from a mixture of ethyl acetate and petrol ether, boiling point 100–20°, gave a pure product which was identical with an authentic specimen prepared by the method of Bergmann and Wolff[1] (see table).

	Product from catalytic oxidation	Reference compound	Mixture
l-Menthol α-D-Glucuronide (hydrated)	m.p. 141–42° $[\alpha]^{21°}D = +45{\cdot}6°$	m.p. 137–38° $[\alpha]^{21°}D = +45{\cdot}9°$	m.p. 141°
l-Menthol β-D-Glucuronide (hydrated)	m.p. 75–77° $[\alpha]^{21°}D = -99{\cdot}3°$	m.p. 79–80° $[\alpha]^{21°}D = -101{\cdot}7°$	m.p. 78–80°

Melting points are uncorrected.

l-Menthol β-D-glucuronide. 100 mgm. platinum black was added to a solution of 500 mgm. *l*-menthol β-D-glucoside monohydrate in 50 ml. water and the oxidation was carried out as described above. The reaction was complete in 4 hr. After removing the catalyst, the glucuronide was precipitated as the ammonium salt and then converted to the free acid[6]. One recrystallization from water gave the impure glucuronide, melting point 65–75°, in 34 per cent yield. A further recrystallization gave the pure glucuronide, which proved to be identical with a

specimen of biosynthetic *l*-menthol glucuronide[6] (see table).

I wish to express my gratitude to Dr. G. A. Levvy for encouragement and advice in this work.

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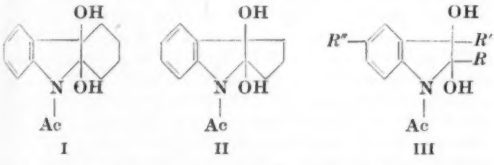
Perhydroxylation of Indole Derivatives by Osmium Tetroxide

THE very various transformations undergone by 9-acetyl-10:11-dihydroxyhexahydrocarbazole (I) have recently aroused some interest[1]. The related compound (II) does not undergo Wagner–Meerwein rearrangements like those given by (I)[2]. Witkop[1a] has satisfactorily explained this failure by pointing out that such rearrangement of (II) would involve the formation of a four-membered ring compound. While this suggestion is convincing, it seemed worth while to confirm that the diols (I) and (II) possess similar configurations, for the Wagner–Meerwein change is markedly affected by the *cis*- or *trans*-configuration of the compound involved, only the *cis*-diols becoming readily rearranged[3]. Further, (I) and (II) have hitherto been prepared by rather different methods.



Most of the small number of known diols of type (III) have been obtained by Perkin, Plant and their associates[4], by the action of nitric acid in acetic acid upon the acylated indoles. We have now prepared such compounds by treating various N-acetylindoles with osmium tetroxide and pyridine in benzene solution, and afterwards hydrolysing the highly crystalline, fawn-coloured esters which were formed. Thus, N-acetyltetrahydrocarbazole gave (I) (found: C, 68·3; H, 7·1; calc. for $C_{14}H_{17}O_3N$: C, 68·0; H, 6·9 per cent), melting point 203–204° alone and mixed with an authentic specimen; and (II) (found: C, 66·7; H, 6·6; calc. for $C_{13}H_{15}O_3N$: C, 66·9; H, 6·5 per cent), melting point 149–151°, identical with the preparation of Plant and Tomlinson[2], was obtained similarly.

Other examples, obtained from the appropriate indoles, which might be mentioned, are (III; $R=R'=$ Ph; $R''=$ H), melting point 206–208° (found: C, 76·8; H, 5·6; $C_{22}H_{19}O_3N$ requires C, 76·5; H, 5·5 per cent), and (III; $R=R'=R''=$Me), melting point 102–108° (found: C, 66·3; H, 7·4; $C_{13}H_{17}O_3N$ requires C, 66·3; H, 7·3 per cent). Likewise, N-acetyl-2:3-dimethylindole gave a product of melting point 130–133° (Plant and Whitaker[5] give melting point 132–134° for (III; $R=R'=$Me; $R''=$H)).

The method of preparation of these compounds proves conclusively that they possess the *cis*-configuration[6].

A more detailed and extended description of these and other experiments in perhydroxylation of indoles will be given later. We are greatly indebted to Dr. Plant and Dr. Tomlinson, who kindly provided specimens of their preparations of (I) and (II).

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Estimation of Deoxycorticosterone by a Modified Hagedorn–Jensen Procedure

Heard, Sobel and Venning[1] demonstrated that estimation of the reducing powers of lipid-soluble extracts prepared from urine provides a measure of the corticosteroid content of such extracts. The value of the method depends upon the presence of characteristic reducing groups in the corticosteroid molecules, making it possible to utilize oxidation reactions similar to those used in the estimation of sugars. Various methods based on this principle have been reviewed by Sprechler[2].

It is of interest in this connexion to report some experimental findings on a convenient and rapid procedure which we have recently developed for the estimation of pure deoxycorticosterone and its acetate in aqueous methyl alcohol solution, based on a modification of the Hagedorn–Jensen blood sugar method[3]. This modification was made possible by employing the reaction which takes place when ammonium molybdate solution is added to potassium ferrocyanide solution in presence of strong acetic acid. The intensity of the brown coloration produced is a direct measure of the amount of ferrocyanide present and may be estimated by a colorimetric or absorptiometric method, thereby avoiding the necessity for the thiosulphate titration.

The standard procedure adopted was as follows: 1 ml. of 50 per cent aqueous methyl alcohol containing deoxycorticosterone or its acetate was measured into a tube, treated with 2 ml. of the Hagedorn–Jensen[3] alkaline ferricyanide reagent, and the tube immersed in a boiling water-bath for 3 min. A blank estimation on 1 ml. of 50 per cent aqueous methyl alcohol was carried out simultaneously. After heating, the tubes were rapidly cooled and the contents made up to 6 ml. with distilled water. 1 ml. of 10 per cent ammonium molybdate solution was added, followed by 5 ml. glacial acetic acid, and, after mixing, the colours (which are stable up to at least 1 hr.) were read on a Spekker photoelectric absorptiometer, using Ilford violet filters.

Representative results showing the effects produced by standard quantities of deoxycorticosterone and its acetate, compared with certain non-reducing steroids, are shown in the accompanying table.

Steroid	Quantity (μgm.)	Extinction
Deoxycorticosterone	50	0·175
	100	0·344
	150	0·505
Deoxycorticosterone acetate	50	0·180
	100	0·350
	150	0·510
Androsterone	45	0·025
Dehydroisoandrosterone	104	0·025
Cholesterol	250	0·025

It will be noted that the reaction distinguishes sharply between deoxycorticosterone or its acetate and the other steroid compounds tested, and that the effects produced by deoxycorticosterone and its acetate are closely comparable. We have found further that the extinction value is proportional to the amount of either up to at least 200 μgm., and that reproducible standard graphs may be obtained over this range with an accuracy ± 5 per cent.

Promising results have also been obtained on application of this method to lipid extracts of urine, and further work on the suitability of the method for the routine estimation of corticosteroids in urine is being carried out in this Department.

We are indebted to Messrs. Organon, Ltd., for supplies of deoxycorticosterone and its acetate.

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Separation of Deoxypentose and Pentose Nucleic Acids

Crude preparations of deoxypentose nucleic acids are almost invariably contaminated with pentose nucleic acids. This admixture renders many studies of the chemical and biological specificity of nucleic acids difficult. A preliminary separation must be carried out before the exact determination of the constituent purines and pyrimidines becomes possible[1]. Only in a few cases (sperm, thymus and, possibly, spleen) will suitable washing of the biological material, prior to its extraction, sufficiently depress the extent of contamination of the nucleic acid specimens[2–4].

Among the methods for the removal of pentose nucleic acids occasionally found useful in this laboratory, the following may be mentioned. (1) Separation by electrophoresis[5]: this mild, but laborious, procedure has proved particularly suitable for the purification of microbial nucleic acids endowed with transforming activity[6]. (2) Fractionation by way of the calcium salts[5,7]: the separation will, however, be far from complete. (3) Purification of deoxypentose nucleic acids by treatment with crystalline ribonuclease[5,7] and of pentose nucleic acids by the action of crystalline pancreatic deoxyribonuclease[8]: the enzyme-resistant 'cores' are, however, left behind. (4) Dialysis against dilute sodium hydroxide of *p*H 13·5 at 30° for 18 hr.[9]: this treatment injures[10], as it purifies, the deoxypentose nucleic acids, though without noticeable change in composition; the pentose nucleic acids are converted quantitatively to mononucleotides[11].

The new method described here permits the almost complete removal of pentose nucleic acids without appreciable loss of deoxypentose nucleic acids. It is based on the observation that under proper conditions pentose nucleic acid is much more readily adsorbed by activated charcoal than is highly polymerized deoxypentose nucleic acid. This diversity appears to be due to a difference in the molecular weight rather than in the chemical nature of these two nucleic acid types. The dialysable fragments[12] resulting from the depolymerization of deoxypentose nucleic acids by crystalline deoxyribonuclease were, in fact, quantitatively adsorbed by charcoal.

A 0·14 *M* sodium chloride solution proved best as the solvent; the extent of adsorption of pentose nucleic acid from distilled water was too small for practical purposes; with 2 *M* sodium chloride solutions greater losses of deoxypentose nucleic acid were incurred. Washed neutral 'Norit A' (pharmaceutical grade) was used as the adsorbent. 'Darco *G*-60' also could be used, though it was found less adsorptive. As a preliminary step, the adsorbent was washed with running tap water for 18 hr., then once with eight volumes of 2 *M* sodium chloride solution and twice with the same quantity of 0·14 *M* sodium chloride solution. The quantitative procedures for testing the purity of the nucleic acid preparations have been noted previously[13]. It is essential that the nucleic acid solutions be thoroughly freed of protein before being subjected to the treatment.

A typical experiment was carried out with a crude preparation of the sodium salt of highly polymerized deoxyribonucleic acid from pig's liver which was contaminated with 30 per cent of pentose nucleic acid. A viscous solution in 0·14 *M* aqueous sodium chloride containing 0·5–1 mgm. of this product per c.c. was shaken at 2° for one hour with 1/15 to 1/20 volume of wet charcoal. After the complete removal of 'Norit' by centrifugation, no pentose could be detected in the supernatant. The recovery of deoxypentose nucleic acid (containing less than 1 per cent of pentose nucleic acid) was of the order of 94 per cent; the loss was partly attributable to the retention of some liquid by the adsorbent.

The treatment has no depolymerizing effect: the recovered deoxypentose nucleic acid showed no change in viscosity, nor did it exhibit thixotropy[10]. In order to exclude the occurrence of a fractionation in the course of this treatment, a solution in 2 *M* sodium chloride containing 1·75 mgm. of calf thymus deoxyribonucleic acid per c.c. was treated three times with larger quantities of 'Norit' (1/8 volume) until only 27 per cent of the original nucleic acid remained unadsorbed. It cannot be stated whether it is significant that the resulting solution had a specific viscosity 26 per cent higher than that of the original solution after the latter had been diluted to the same nucleic acid content. No indications that a fractionation with respect to chemical composition had taken place were, however, obtained. The analysis of the final product for individual purines and pyrimidines showed the proportions of nitrogenous constituents to be identical with those of the untreated deoxyribonucleic acid[1,2].

Full accounts of the successful application of this procedure to the purification of deoxypentose nucleic acid preparations, especially from micro-organisms and from plants, will be published in due course.

This work was supported by research grants from the National Institutes of Health, United States Public Health Service, and from the Rockefeller Foundation.

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Action of Phytopathogenic Bacteria on Pectate Gel

MANY of the bacteria which cause diseases of plants attack their hosts, in the first instance, by breaking down the pectic substances of the middle lamella. This is particularly true of the soft-rot organisms and of those pathogens causing diseases of the parenchyma.

During the course of study on the bacterial die-back and canker of poplar[1], it has been found that the liquefaction of pectate gel is a sound criterion by which the pectolytic abilities of parasitic organisms may be demonstrated. Previous work[2,3] with pectate gel has been mainly confined to soft-rot organisms. By this present method, it has been possible to extend the use of this medium to other pathogens. This medium has the following advantages: (1) it sets rapidly; (2) the action of the bacteria is amplified by the presence of sodium asparaginate, which most of the organisms can utilize as an extra source of carbon and nitrogen; (3) no adjustment of *p*H is needed, provided that the sodium pectate used is neutral or slightly alkaline.

The medium was prepared as follows: 500 ml. distilled water was put into a one-litre beaker with a mechanical stirrer adjusted so that its speed remained constant during the whole process. It was heated with a bunsen burner, and when the water temperature reached 70° C., 15 ml. bromthymol blue followed by 5 gm. sodium pectate were added and the temperature kept constant for five minutes. When the temperature had dropped to 60° C., 2·5 ml. of 10 per cent calcium chloride in water, 0·5 gm. ammonium dihydrogen phosphate, and 1·0 gm. sodium asparaginate were added in succession. The temperature was kept constant for 10 min. The final *p*H of the mixture was between 7·0 and 7·2 (bluish-green) and no adjustment was therefore needed. The medium was then poured into tubes quickly, and autoclaved momentarily at 15 lb./sq. in. The tubes were placed standing in water at room temperature until the gel set in three to four days. They were then stored in a cool place.

A number of organisms, covering the four genera of bacterial plant pathogens, were inoculated by needle stabs into the medium.

The following species of the genus *Pseudomonas* were used: *Ps. syringæ*, *Ps. syringæ f. sp. populea*[1], *Ps. mors-prunorum*, *Ps. angulata*, *Ps. tabaci*, *Ps. medicaginis f.sp. phaseolicola* and the saprophyte *Ps. fluorescens liquefaciens*. All except *Ps. fluorescens* produced slight to moderate liquefaction and full thick liquid; the medium became alkaline. *Ps. fluorescens* did not liquefy the medium although it grew readily in it.

Of the genus *Xanthomonas* the following species were used: *X. campestris*, *X. citri*, *X. malvacearum* and *X. begoniæ*. The first two organisms produced moderate liquefaction and clear liquid, while the others produced slight thick liquefaction. In all cases the medium remained neutral.

All the species of *Corynebacterium* used, namely, *C. fascians*, *C. tritici*, *C. michiganense* and *C. flaccumfaciens*, produced slight to moderate liquefaction, thick liquid and slight alkalinity.

Different types of action were produced by pathogens belonging to the genus *Bacterium*. In the first type, *B. aroideæ*, *B. carotovorum* and *B. phytophthorum* produced moderate liquefaction, semi-transparent liquid and acid. In the second type, *B. salicis* produced less liquefaction, thicker liquid and no change in *p*H. In the third type, *B. tumefaciens* produced slight liquefaction, still thicker liquid and alkalinity. The saprophyte *B. lathyri* did not liquefy pectate gel.

It is suggested that the differences in the extent of liquefaction by the various organisms may be attributed to the nature and amount of pectic enzymes they secrete. Two enzymes may be concerned with the breakdown of the pectic salts present in the medium, namely, pectinase and protopectinase. While soft rot organisms secrete a large amount of both enzymes, saprophytic organisms, on the other hand, may secrete pectinase only. Vascular and hyperplastic organisms secrete very little protopectinase, as they do not depend, in their parasitism, on the breakdown of the middle lamella.

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Effect of Vitamin B_{12} on the Synthesis of Protein and Nucleic Acids in the Liver

IT is known that the cytoplasm content of the liver is determined by protein nutrition[1], and recently vitamin B_{12} has been shown to promote amino-acid assimilation[2]. A decrease in liver basophile cells (attributable to ribonucleic acid) is observed in rats deficient in vitamin B_{12}[3]. The vitamin also protects against hepatic damage during carbon tetrachloride intoxication, which causes a considerable reduction in the

Effect of Vitamin B_{12} on the Protein and Nucleic Acid Contents of the Liver

Dietary condition	No. of animals	Liver protein nitrogen	Liver nucleic acid phosphorus		
			Total	Deoxyribonucleic acid	Ribonucleic acid
		(mgm. per 100 gm. body-weight)			
Fasted 48 hr.	8	85 ± 1·6	3·88 ± 0·30	0·90 ± 0·08	2·96 ± 0·19
Re-fed adequate 10 per cent casein diet :					
(*a*) without B_{12}	8	101 ± 2·1	4·14 ± 0·20	0·90 ± 0·04	3·22 ± 0·20
(*b*) with parenteral B_{12} supplement	8	109 ± 1·9	5·24 ± 0·46	1·16 ± 0·03	4·13 ± 0·18

ribonucleic acid content of the liver[4]. All these findings suggest that vitamin B_{12} may influence protein as well as nucleic acid metabolism in the liver. We have sought direct experimental evidence for this in studies based on the regeneration of the labile liver cytoplasmic proteins in the rat following a brief fast. The results of a typical experiment are presented here.

Adult male albino rats weighing 180–220 gm. (average 200 gm.) were chosen for the experiment. They were kept on a vitamin B_{12}-free ration for four weeks to deplete as much of their tissue reserves of the vitamin as possible. To prevent intestinal biosynthesis of the vitamin, 1 per cent of sulphasuxidine was included in the diet. The diet used during the preparatory period, and also for refeeding after the fast, was the same and had the following composition : casein (prepared from commercial casein and devitaminized by exhaustive extraction with ethyl alcohol) 10, coconut oil 10, cane sugar 10, corn starch 65, salt mixture 4, and sulphasuxidine 1. The experimental animals received adequate amounts of vitamins A and D, and all pure vitamins of the B-complex excepting B_{12}.

The duration of the fast was 48 hr. and the period of refeeding four days. Comparable groups of rats were sacrificed at the end of the fast and after refeeding. During the refeeding period, one group served as a control, and the animals in a parallel group received daily 3 μgm. of vitamin B_{12} (Merck's 'Cobione') each intraperitoneally, the food intake in both the groups being restricted to 12 gm. a rat per diem.

The livers were excised from the animals under amytal anæsthesia after thorough bleeding through the abdominal aorta, immediately weighed and homogenized in ice-cold water in a Waring blendor. Aliquots of the homogenate were used for the various analyses. The true protein nitrogen was estimated after precipitating the proteins with trichloracetic acid (5 per cent). The procedure of Brues *et al.*[5] was adopted for fractionating the deoxyribonucleic and ribonucleic acids, their content being determined by estimating the acid-insoluble, non-lipid phosphorus in the different fractions. The results are given in the accompanying table. The liver constituents are expressed in terms of 100 gm. of the body-weight of the animals just prior to the fast.

It is evident from these results that vitamin B_{12} stimulates both protein and nucleic acid synthesis in the liver. The liver protein nitrogen increment over the fasted level is raised by nearly 50 per cent, and the total nucleic acid content of the liver by about 27 per cent in the group receiving vitamin B_{12} as compared to the control. The increases in the deoxyribonucleic and ribonucleic acid components are of the same order as in the total nucleic acids. The greater regeneration of liver protein in the animals receiving vitamin B_{12} is presumably due to its effect in enhancing amino-acid utilization. The changes in the nucleic acid content of the liver produced by vitamin B_{12} are much more than what would correspond to those in its protein content, and are therefore to be considered a specific effect of the vitamin. The rise in the liver deoxyribonucleic acid content brought about by the vitamin appears particularly noteworthy in view of the fact that it is not affected by fasting and even wide variations in dietary protein content[1b,6]. We believe these results are the first experimental proof of the direct intervention of vitamin B_{12} in mammalian nucleic acid metabolism.

Further studies relating to the effects observed are in progress. A detailed account of the findings will be published at a later date.

We are grateful to Dr. V. Subrahmanyan, director of this Institute, for encouragement and interest in the work.

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Crystallization of the α-Amylase of *Aspergillus oryzæ*

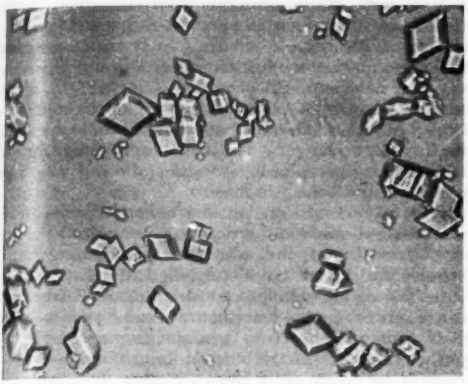
Comparison[1] between crystalline α-amylases of malt[2], bacteria[3], hog pancreas[4], human pancreas[5] and saliva[6] indicate that their properties vary regularly in that order, emphasizing the close relationship which exists between proteins of the same biological activity from the vegetable to the animal kingdom.

As would be expected for a bacterial enzyme, *B. subtilis* α-amylase is much more closely related to the animal than to the vegetable enzymes. For example, as is the case for animal amylases, it is activated by chloride ions. Calcium ions, which are indispensable to malt α-amylase[7], are ineffective.

In order to throw light on variations which occur among the amylases, it appeared of interest to study an enzyme from a material which, from a systematic point of view, would be intermediate between malt and bacterial amylase. With that purpose in mind, we prepared pure amylase of the mould *Aspergillus oryzæ* (taka-diastase).

An aqueous 1 : 6 suspension of 'Clarase 900' (Takamine Laboratory, Clifton, New Jersey, U.S.A.) is left for 12 hr. in the cold. After centrifugation, the dark brown liquor is brought to 0·8 saturation with solid ammonium sulphate. The precipitate obtained by filtration on 'Filter Cel' is dissolved, the solution is adjusted to *p*H 6·0 and fractionated by acetone. The 40–58 per cent acetone fraction is dissolved in a small amount of water. This solution (*p*H 7·2) is brought to 0·75 saturation with sodium chloride and then fractionated between 0·54 and 0·70 saturation

with a saturated solution of ammonium sulphate. The fractionation is repeated twice under approximately the same conditions. The last precipitate is now dissolved in the minimum quantity of water, and the slightly brown solution, adjusted to *p*H 7·2, is left in the cold. Crystals appear after two or three days, and, after a week, at least 50 per cent of the activity of the suspension is found in the crystalline material. This has been recrystallized (see photograph).



Crystals of α-amylase from *A. oryzæ*. × 150

A product the activity[4] of which was 2,400 mgm. maltose/mgm. nitrogen has been obtained. The total yield was approximately 15 per cent with a fourfold activity/nitrogen enrichment, based on the original extract. The purified enzyme behaves as a strictly homogeneous substance in the electrophoresis apparatus at all *p*H's investigated, namely, 4·7–8·6. Its isoelectric point lies at ~ *p*H 4.

The enzyme is stable in the cold between *p*H 4·7 and 7·8 and can be dialysed for long periods against aqueous or salt solutions without any loss of activity. Its activity is not dependent upon the presence of chloride ions as for the animal and bacterial amylases, nor does it need calcium ions as does malt α-amylase.

The accompanying table compares some of the properties of taka-amylase with those of other crystalline amylases.

Properties	Crystalline α-amylases of				
	Malt	*Asperg. oryzæ*	*B. subtilis*	Pig pancreas	Human pancreas and saliva
Mgm. Maltose/mgm. N	2,350	2,400	3,600	4,000	6,200
Optimum *p*H	4·7–5·4	5–7	5·3–6·8	6·9	6·9
Solubility (per cent)	>15	>10	~6	0·3	0·3
Activation energy (cal./mol.)	7,050	10,500	13,500*	13,500	13,500
Activation by Ca^{++}	+	−	−	−	−
Activation by Cl^{-}	−	−	+	+	+

* At temperatures less than 20° C.

In conclusion, although the properties of crystalline taka-amylase are intermediate between those of malt and bacterial amylase, this enzyme should be considered separately due to the fact that its activity does not depend on the presence of any ion.

We wish to express our thanks to Prof. Kurt H. Meyer for many helpful suggestions and discussions in connexion with this work.

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'Streptozyme', a Lytic Enzyme from Lactic Streptococci

IT has already been shown that antibiotic-producing streptococci other than the lactic group (Lancefield's Group *N*) are rare. The difficulties of survey were increased by toxic metabolic by-products, lactic acid in particular giving false inhibitory reactions on agar[1]. During the later stages of this work (unpublished) neutralized culture fluids were used to overcome the inhibitory effects of lactic acid. A cylinder-plate method was used for assays with *Staphylococcus aureus* (491) as the test organism. Several strains of streptococci were isolated from silage, the neutralized culture fluids of which gave 20-mm. zones of inhibition, while the un-neutralized acid culture fluids were inactive. These cultures were proved serologically to belong to Group *N* (*Str. lactis*), yet the inhibitory substance produced is inactive in acid media and is heat-labile, characters distinguishing it from the main antibiotic, nisin, produced by *Str. lactis*[2].

After centrifuging, both cells and supernatant were inactive and the inhibitory substance appeared to be mainly associated with the intact living cells. When growing cells were killed with nisin (200 units/ml.), they promptly became autolysed. Autolysis depended on *p*H (ceasing completely at *p*H 6 or below) and on the age of the culture. The activity of cultures more than 10 hr. old declined gradually, even when the *p*H was maintained by periodic neutralization at 6·5.

The autolytic nature of this enzyme clearly distinguishes it from lysozyme; it also appears to be more heat-labile. The lytic effect is not due to bacteriophage, since a cell-free culture filtrate was incapable of lysing living cells, but there was some activity against a heat-killed suspension. The name 'streptozyme' is proposed for this enzyme.

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Deoxyribosenucleic Acid Synthesis during Cell Division in Mouse Epidermis

A study of the energy relations of epidermal mitosis in the adult mouse has shown that active production of energy is of vital importance only during that period which immediately precedes the prophase and for which Bullough[1] has suggested the term 'antephase'. By the time an epidermal mitosis becomes recognizable, it is so highly independent of external conditions that it may be regarded as a classical example of an all-or-none reaction. It appears that the critical importance of the active production of energy in the antephase may be related either to a demand for energy at this time, or to the necessity for energy storage for the maintenance of the cell during some two hours of division and reconstitution[2].

In examining the first of these alternatives it was noted that the view is widely held that an increase in the nucleic acid content of the nucleus occurs during early prophase. Thus Ris[3], using the photometric method of Pollister and Ris[4] for a study of the total nucleic acid content and the deoxyribosenucleic acid content of the cells of onion roots and grasshopper testes, has concluded that "during the mitotic prophase and the first meiotic prophase the constituents of chromosomes increase about twofold". It was suggested by Bullough[2] that this conclusion, if it is also applicable to mouse epidermis, may suggest a reason for the active production of energy in the antephase, since any substantial increase in the nucleic acid content of the cell at this time must involve a significant amount of work.

In contradiction to this, however, Pasteels and Lison[5], using the technique of Lison[6], have shown in the erythrocytes of embryo rats, the crypts of Lieberkühn of adult rats, and chick heart fibroblasts "qu'il n'y a pas de modification de la teneur en D.N.A. au cours de la prophase ; qu'à l'anaphase cette teneur tombe de moitié pour chaque noyaufils ; que la teneur initiale se reconstitue immédiatement au moment de la reconstitution du noyau". Lison and Pasteels[7] have also described a similar pattern of deoxyribosenucleic acid synthesis during mitosis in sea urchin eggs. It was therefore necessary to determine the conditions in mouse epidermis before attempting to relate energy production to deoxyribosenucleic acid synthesis, and measurements have now been carried out on the ear epidermis, the tissue in which the original observations on energy production were made. The mice used were four-month old Kreyberg white label males. These were killed while asleep in order to obtain a high number of epidermal mitoses, their ears were sectioned, and the deoxyribosenucleic acid content of their epidermal nuclei was estimated by the method described by Lison[6] (see table) ; for comparison, the deoxyribosenucleic acid content of lymphocyte nuclei is also shown.

Deoxyribosenucleic Acid Content of Nuclei in the Malpighian Layer of the Ear Epidermis of Adult Male Mice (Arbitrary Units)

Type of nucleus	Number of nuclei examined	Deoxyribosenucleic acid content Extreme values	Mean and standard error
Interphase	150	123–642	—
Prophase	1	362	—
Metaphase	20	333–457	338·7 ± 7·5
Telophase × 2	28	384–568	460·0 ± 10·6
Lymphocyte	26	230–327	276·9 ± 5·3

The measurements showed that in the Malpighian layer, which alone contains cells capable of division, the deoxyribosenucleic acid content of interphase nuclei varied widely. Clearly the Malpighian cells were not homogeneous, and, using lymphocyte values as standard, it was found that they could be roughly divided into three groups : those with a deoxyribosenucleic acid content equal to that of the lymphocytes, those with a lower content, and those with a higher content. It was apparent that only the cells of the last group, those with the highest deoxyribosenucleic acid content, could undergo division, since all the nuclei measured in prophase and metaphase showed similarly high values. During early anaphase each of the two newly forming groups of chromosomes had only half the deoxyribosenucleic acid content of the metaphase nucleus. During late anaphase and telophase, however, deoxyribosenucleic acid synthesis was rapid so that, by the time each daughter cell entered the interphase, it again showed the high level typical of the prophase.

Evidently, conditions in the ear epidermis of the adult male mouse closely resemble those in the crypts of Lieberkühn of the adult rat, concerning which Pasteels and Lison[5] have concluded that "au cours de l'intercinèse, les cellules ont des teneurs très différentes ; en revanche, les valeurs observées à la métaphase sont d'une très grande homogénéité ; la synthèse en D.N.A. débute à l'ana-télophase et se poursuit au cours de la reconstitution du noyau ; la valeur anaphasique est ainsi progressivement doublée ; et une valeur égale à celle de la métaphase est rétablie au début de la nouvelle intercinèse".

These conclusions appear to contradict any suggestion that the high production of energy observed during the antephase may be related to active nucleic acid synthesis at that time, and to be in agreement with the alternative hypothesis that the antephase is the period when energy is stored for the support of all the various cellular activities, including synthesis of deoxyribosenucleic acid, which occur during the ensuing division. A fuller account of these observations will be given elsewhere, together with a description of conditions in the superficial epidermal layers.

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A New Biological Method for Evaluating the Efficiency of Insecticides for the Protection of Sheep against Blowfly Strike

The protection afforded to sheep against blowfly strike by the new synthetic chlorinated hydrocarbon insecticides applied to the fleece has been shown to be the result of two different actions. Insectary tests have demonstrated distinct repellent effect and the prevention of oviposition in the case of gravid female

flies, whereas implantations of first instar larvæ, according to the method of McLeod (1937), have indicated the larvicidal role.

The retention of larvicidal properties and the consequent continued protection of sheep long after all demonstrable repellency has disappeared indicate that larvicidal properties are of much greater importance than fly repellence.

It is known that the larvæ of the primary blowfly, *Lucilia cuprina* Wied., live principally upon the serous fluid exuding from the superficial wounds produced by them. In order to determine the minimum concentration of insecticide capable of destroying all first-stage larvæ in a nutritional medium, a series of *in vitro* tests was conducted. First instar larvæ were placed in glass tubes, 3 in. × 1 in., each containing a pledget of cotton-wool soaked in serum in which was suspended the test insecticide in wettable powder form in serial dilutions over the range 1,000–0·004 parts per million. Insecticides in wettable powder form were chosen in order to eliminate the possible larvicidal effect of organic solvents. The tubes were plugged with cotton-wool and held in an incubator at 27° C. (80·5° F.). Observations on mortality were made at 1, 3, 6, 24, 48 and 72 hr. It was unnecessary to extend the observations beyond this period as the maggots become more resistant to insecticidal action with increasing age, and if not killed within 72 hr. will not be affected by the strength of insecticide applied.

Four replications of the above test gave the minimum concentrations of insecticide in parts per million to kill all young *L. cuprina* larvæ in the time specified shown in the accompanying table.

Insecticide	Time (hr.)				
	3	6	24	48	72
Dieldrin	1000	250	16	4	1
Gamma-BHC	250	64	16	4	4
Aldrin	1000	1000	16	16	4
'Methoxychlor'	1000	250	16	16	4
DDT		1000	16	16	4
Chlordane			250	64	16
Toxaphene		1000	250	64	64
DDD (TDE)				64	64

The eight compounds tested fall naturally into four groups according to their larvicidal properties, and both DDT and gamma-BHC are included in the same group as they are capable of killing the larvæ at a dilution of 4 parts per million.

Sheep may be protected for long periods when treated with relatively high concentrations of these synthetic insecticides. Under experimental conditions, DDT at 5 per cent *pp*-isomer affords protection for approximately three months, whereas BHC at 0·5 per cent gamma isomer still protects after six months, provided that at the time of application the wool has a length of 1–1½ in. Under South African conditions, wool grows at the fairly constant rate of ½ in. per month, so that at the end of three to six months the wool fibres have increased in length by about ¾–1½ in. This new wool, untreated at the time of the original application, was found to be capable of killing first instar larvæ.

In order to ascertain the larvicidal properties of treated wool at various stages after treatment, a group of sheep bearing wool of fibre length 1¼–1¾ in. were treated with the eight different compounds listed in the table in wettable powder form at a concentration of 0·5 per cent of the active ingredients. An area over the rump approximately 12 in. in diameter was thoroughly soaked with each suspension. Commencing nine weeks after treatment, samples of wool of about 0·5 gm. were removed weekly from the treated area on each sheep for laboratory tests, and first instar larvæ were implanted on these areas at the same time.

Half an inch of wool, representing the new growth, was removed from each sample. These portions and the remaining portions of old wool were placed separately in glass specimen tubes and well soaked with normal serum. Into each tube was then implanted 50–100 first instar larvæ of *L. cuprina* for incubation and observation.

The time of survival of the larvæ served as an index of the concentration of insecticide present in the wool samples. By comparing the rates of mortality with those given in the table, an accurate estimation of the concentration of insecticide in the particular portion of the fleeces tested could be obtained.

It was possible to deduce from these *in vitro* tests that the sheep were no longer protected against strike when the concentration of insecticide in the newly grown fleece fell below the larvicidal level, namely, 4 p.p.m. in the case of DDT and BHC. When the larvæ survived in the tubes, strikes developed on the sheep upon which larvæ had been implanted. This method was sufficiently sensitive to indicate partial protection of sheep by observing retarded larval development.

The method described has disclosed distinct differences in the behaviour of the different insecticides in the fleece of sheep. The concentration of gamma-BHC, aldrin, dieldrin, chlordane, and to a lesser extent toxaphene, in the newly grown wool was sufficient to be fully larvicidal nine weeks after application of the insecticide to the sheep which were protected against fresh strike. In the case of DDT, 'Methoxychlor' and DDD(TDE) the larvæ remained alive in the tubes containing the new-growth wool samples, and strikes developed upon the sheep.

The compounds in the first group appear to possess remarkable powers of diffusion down the wool fibres, where they persist at concentrations lethal to first instar larvæ for considerable periods. DDT and its allied compounds, on the other hand, appear to remain fixed in the wool originally treated, and protect sheep for considerably shorter periods in spite of possessing equal larvicidal properties.

Tests conducted to date have revealed that gamma-BHC, aldrin and dieldrin applied originally at 0·5 per cent concentration will diffuse more than 1½ in. along the wool fibre and so provide protection for six months.

The length of wool at the time of treatment and the initial concentration of insecticide applied play an important part in the extent to which diffusion will occur and the degree of protection afforded.

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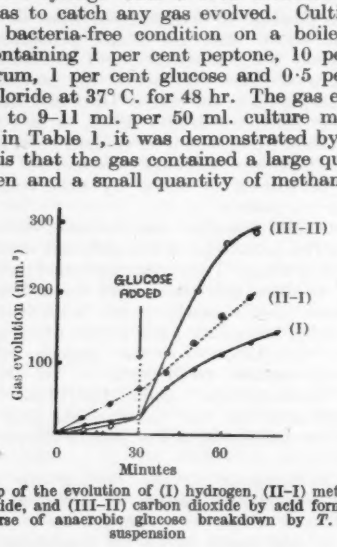
Hydrogen Evolution by *Trichomonas fœtus*

Trichomonas fœtus, a polyflagellated protozoon, is parasitic in the vagina of the cow and causes impaired reproduction. J. Andrews and T. von Brand[1] carried out some quantitative studies on glucose consumption by *T. fœtus* during cultivation, and then also found that a gas, which burned explosively when mixed with air, was produced by the organism when growing in serum broth with 0·1 per cent glucose. This fact suggested that it might be hydrogen.

Table 1. Composition of the Gas Evolved during Anaerobic Cultivation

Exp. No.	Gas evolved (ml.) per 50 ml. medium	Gas analysis (per cent) Carbon dioxide	Oxygen	Methane	Hydrogen	Nitrogen
1	10·0	0·00	1·77	1·89	83·73	12·61
3	9·4	0·00	6·00	0·30	73·65	20·04
7	11·9	1·96	5·57	2·05	78·65	11·77

We cultivated *T. fœtus* anaerobically in a 200-ml. injection syringe with a cock attached to its nozzle so as to catch any gas evolved. Cultivation was in a bacteria-free condition on a boiled beef extract containing 1 per cent peptone, 10 per cent bovine serum, 1 per cent glucose and 0·5 per cent sodium chloride at 37° C. for 48 hr. The gas evolved amounted to 9–11 ml. per 50 ml. culture medium. As shown in Table 1, it was demonstrated by micro gas analysis that the gas contained a large quantity of hydrogen and a small quantity of methane.



Relationship of the evolution of (I) hydrogen, (II–I) metabolic carbon dioxide, and (III–II) carbon dioxide by acid formation in the course of anaerobic glucose breakdown by *T. fœtus* suspension

By using the saline suspension of *T. fœtus*, we further investigated manometrically this hydrogen evolution under anaerobic conditions. In order to differentiate metabolic carbon dioxide from the hydrogen evolved and formation of acid, three flasks (Warburg manometers) were used, of which both flask I, containing 20 per cent potassium hydroxide in the centre well, and flask II, without potassium hydroxide, were filled with nitrogen as the gas phase, and flask III was kept in an anaerobic carbon dioxide–bicarbonate buffering state. We found a gas other than carbon dioxide in flask I, and estimated the metabolic carbon dioxide evolution by subtracting the volume of gas evolved in flask I from that in flask II, and acid formation by the determination of bicarbonate remaining, as shown in the accompanying graph (in the presence and absence of glucose as substrate). Table 2 shows that this hydrogen evolution depends on the amount of glucose added and not on the peptone, and that it increases somewhat

Table 2. Effect of Substrates and pH on the Hydrogen Evolution

Substrates	Final concentration	pH	Relative amount of hydrogen evolved during 30 min.
Endogenous		7·0	100
Glucose	0·005 mol.	7·0	130
	0·01	7·0	234
	0·01	4·8	133
	0·01	8·5	264
	0·015	7·0	280
Peptone	1 per cent	7·0	99
Pyruvate	0·01 mol.	7·0	150
Formate	0·01	7·0	128

on the addition of pyruvate or formate. These facts suggest that the evolution of hydrogen is connected with the anaerobic carbohydrate metabolism accompanied with acid formation.

Further investigations showed that the main end-product of this acid formation is neither lactic nor pyruvic acid, but succinic acid. These results suggest that the anaerobic glucose breakdown differs considerably from the usual glycolytic process.

We are indebted to Dr. C. Koyama for the micro gas analysis.

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Helical Thickenings and Micellar Orientation in the Secondary Wall of Conifer Tracheids

The suggestion that the cytoplasmic surface possesses the capacity to govern the micellar orientation of the cell wall has been made both by Frey-Wyssling[1] and Preston[2], whereas the possible influence of forces arising from cell turgor and protoplasmic streaming have been discussed by Castle[3]

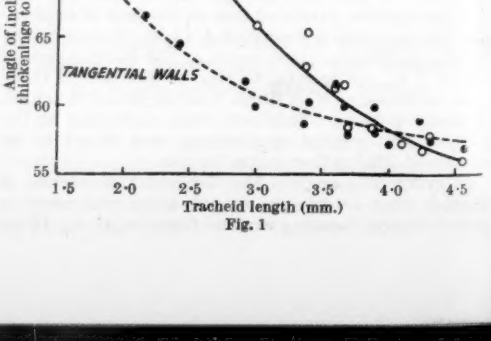

Fig. 1

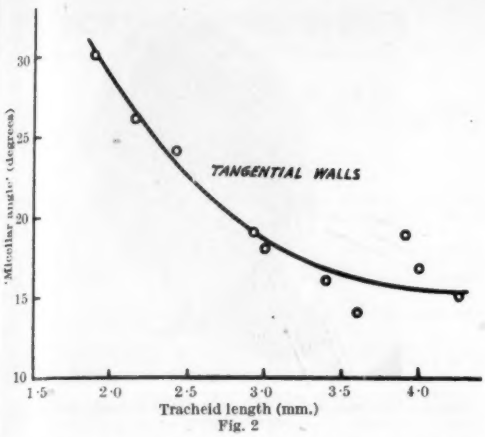

Fig. 2

and by van Iterson[4]. Difficulties in technique have prevented any direct experimental proof of either hypothesis. The formation of cell-wall thickenings which are present in the prosenchyma of many plants has, however, been shown by Cruger[5] and others[6] to reflect a structural differentiation in the cytoplasm of a pattern similar to that of the later-formed thickenings, and recognizable upon plasmolysis. In conifer tracheids the phenomenon has been illustrated diagrammatically by Jeffrey[7], although it is not clear whether his diagram was based on direct examination or analogy with other cells. These observations, however, point clearly to the influence of the cytoplasm in governing the orientation of cell-wall thickenings, to the axis of which the micelles of cellulose are parallel[8]. As the thickenings are an intrinsic part of the cell wall, and in view of the cytoplasmic differentiation which precedes their development, it becomes of interest to consider whether further evidence can be obtained to indicate a similar function of the cytoplasm in governing micellar orientation in the cell wall generally.

In conifer tracheids the normal secondary cell wall consists of three layers of different helical micellar orientation such that in the outer and inner layers the micelles make a large angle ('micellar angle') with the longitudinal cell axis, whereas in the middle layer this angle is small[9,10]. A remarkable feature of this organization demonstrated by Preston[11,12] for the middle layer is that the micellar angle becomes less with increasing cell-length, that is, the helix becomes steeper. It was noted further by Preston[11] that the micellar angle was greater on the radial than on the tangential walls. The relation between cell-length and micellar orientation has since been demonstrated to apply also to the outer layer of the secondary wall[13] as well as to organization of the secondary wall in other cells[12].

The demonstration of a similar relation between cell length and the orientation of the helical thickenings in species in which they occur could be regarded as support for the assumption that factors which govern the orientation of such thickenings (and of their constituent micelles) also govern the micellar orientation of the cell wall. Accordingly, a study was made of the variation in the angle of orientation of the helical thickenings with respect to the increase in cell-length which occurs in successive growth-rings from the centre of both stems and branches of conifers. The results obtained for *Pseudotsuga taxifolia* (stem – late wood) are shown in Figs. 1–3. Early wood from the *Pseudotsuga* and late wood of *Taxus baccata* (branch) gave parallel results. The 'micellar angle' of the middle layer of the secondary wall was determined from the spread of the 002 arc of the X-ray diffraction diagrams of the specimens and has been plotted for comparison (Fig. 2). The number of turns per cell of the spiral thickenings was found to increase with cell length (Fig. 3). In both specimens two helices were observed in each cell.

From Fig. 1 it is clear that the change in the angle orientation of the helical thickenings with cell length paralleled that of the micellar orientation of the middle layer of the secondary wall. Furthermore, in *Pseudotsuga*, both in early wood and in late wood tracheids, the angle of orientation of the thickenings was greater on the radial than on the tangential walls, which is a result similar to that obtained earlier by Preston[11] for the micellar orientation in the middle layer of the secondary wall. The suggestion that the angle of orientation of the thickenings is a function of cell wall thickness[14] is not confirmed by the present results, as in both the early wood and late wood of *Pseudotsuga* the change in orientation with increasing cell length was observed with little or no change in cell wall thickness.

If it is assumed that the change in orientation and number of turns of the helical thickenings with increasing cell length reflects a similar and prior differentiation of the cytoplasm, then the change in orientation cannot be attributed to the unwinding of a helically organized protoplast in the ageing cambium. The greater number of turns in the longer cells suggests the synthesis of additional cytoplasmic material, as the dimensions of the cells differentiating from the cambium increased. This is of interest in relation to the concept[15] that helical form may originate from rectilinear growth on the surface of a cylindrical object and may have implications in relation to cases of so-called "spiral" growth of plant cells[16]. Although admittedly of an indirect nature, it is considered that the present observations give added support to the view that the cytoplasmic surface is a major factor in determining micellar orientation and may give some indication of the complex

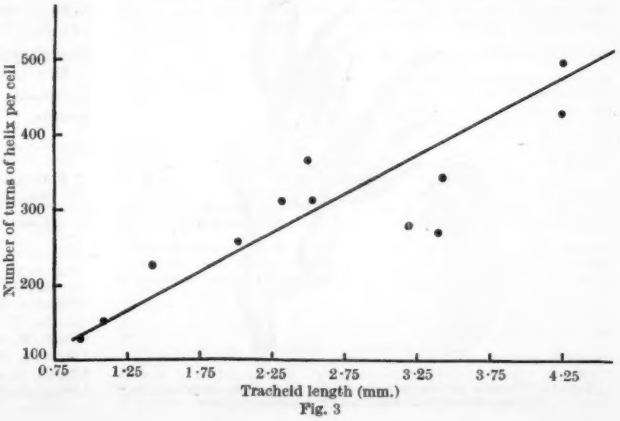

Fig. 3

morphogenic factors involved in the development of the fine structure of the cell wall.

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Spermatheca in Sucking Louse

Tee spermatheca is stated to be absent, by Patton and Cragg[1], in the Anoplura, *Pediculus humanus*, and also by Florence[2] in *Hæmatopinus suis*. But Keilin and Nuttall[3] indicate the existence of a spermatheca in their figure of the reproductive system of *P. humanus*. Qadri[4] disputes this finding and points out that a spermatheca is also absent in *Hæmatopinus tuberculatus*.

On reference to the literature, we find that Mjöberg[5] records the presence of a spermatheca, but only in two species of Anoplura, *Linognathus angulatus* and *Acanthopinus sciurinus*, and gives a brief description of the structure of an empty spermatheca. Ferris[6], in summing up the generic character of *Linognathus* End, mentions the presence of a spermatheca, the opening of which is marked by a sclerotic scar. In view of discrepancy regarding the existence of a spermatheca in sucking lice, we have examined a few related species. We find that the spermatheca exists in the cow-louse, which we provisionally identify as *Linognathus vituli* (Linn.). But the structure is quite different from that given by Mjöberg, in so far as there is no chitinous disk on the spermatheca near the origin of its duct, nor is there any sclerotic scar as mentioned by Ferris. The spermatheca in this species is a large club-shaped sac, bent in the middle and lying to the left of the median line. It opens dorsally into the vagina, by a short duct (Fig. 1). The spermatheca, in one out of ten specimens, contained oval-shaped spermatophores, varying in number from one to eight. In the photomicrograph (Fig. 2) a single spermatophore is shown within the spermatheca. In the majority of cases the spermatheca is empty. The shape of the spermatheca changes as it becomes distended with spermatophores. The occurrence of spermatophores within a spermatheca is of special interest, as it has not been reported by previous investigators, and Wigglesworth[7] remarks that spermatophores are never transferred to the receptaculum of the female. The disproportionate number of females to males, namely, 3 : 1 in the cow-louse, is noteworthy. We confirm that the male possesses a tubular seminal vesicle and accessory glands, as pointed out by Mjöberg and others.

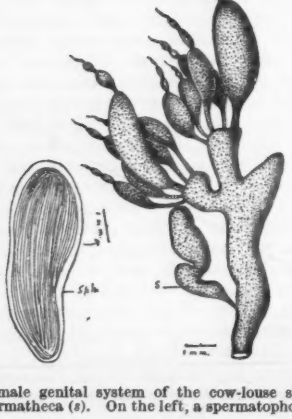

Fig. 1. Female genital system of the cow-louse showing the spermatheca (*s*). On the left, a spermatophore

Fig. 2. Photomicrograph of a spermatophore (*sph*) within the spermatheca

We also wish to record the presence of a spermatheca in the elephant-louse *Hæmatomyzus elephantis* Piag., as there is no mention of it in the descriptions of previous authors.

We wish to thank the Director of the School of Tropical Medicine, Calcutta, for the photomicrograph.

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P. Sen Sarma

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Zoology Department,
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May 1.

[1] Patton, W. S., and Cragg, F. W., "Text-book of Medical Entomology" (1913).
[2] Florence, L., Cornell Agr. Expt. Sta. Mem., 707 (1921).
[3] Keilin, D., and Nuttall, G. H. F., *Parasit.*, **22**, 475 (1930).
[4] Qadri, M. A. H., Aligarh Muslim Univ. Pub. (Zoo.), No. 1, 18 (1948).
[5] Mjöberg, E., *Arkiv. Zool.*, **6**, 255 (1910).
[6] Ferris, G. F., Stanford University, Series 2 (5), 67 (1932).
[7] Wigglesworth, V. B., "The Principles of Insect Physiology", 385 (1924).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 8

PHYSICAL SOCIETY, ACOUSTICS GROUP (in Room C4 (East Wing), King's College, Strand, London, W.C.2), at 5.30 p.m.—Mr. P. E. Doak: "The Pulse Response of Auditoria".

Tuesday, October 9

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. Daryll Forde: "Strange Families".*

CHADWICK PUBLIC LECTURE (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—Mr. F. E. Bruce: "Some International Aspects of Environmental Hygiene".*

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

INSTITUTE OF PHYSICS, EDUCATION GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Prof. A. D. Ross: "Experiences in Education in Science in Australia".

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Discussion on "The Education of the Chemical Engineer by Part-time Study".

ROYAL SOCIETY OF MEDICINE, EXPERIMENTAL MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Discussion on "Aureomycin" (to be opened by Dr. B. Duggar, Dr. J. G. Scadding and Lieut. J. Killough, U.S.N.).

UNIVERSITY OF LONDON (at the Assembly Hall, Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Prof. E. Adrian, O.M., F.R.S.: "The Scientific Basis of Medicine, 1, The Scientific Approach to Medical Research".*
(Further Lectures on October 11, 16, 18, 23, 25 and 30, November 2, 5, 7, 14, 16, 20, 23, 27 and 29, December 4, 6 and 11.)

ILLUMINATING ENGINEERING SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—Mr. J. G. Holmes: Presidential Address.

TEXTILE INSTITUTE, YORKSHIRE SECTION (at the Midland Hotel, Bradford), at 7.15 p.m.—Mr. R. G. Oversby: "My Impressions of Textile Technical Training, Research and Production in the Textile Industry of the United States of America".

Wednesday, October 10

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 2.15 p.m.—Symposium on "The Use of Isotopes in Microbiology".

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Symposium on "Acid Sludge—its Utilization and Disposal".*

Thursday, October 11

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. D. R. Newth: "Lamarck and Neo-Lamarckism".*

UNIVERSITY OF LONDON (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at 5 p.m.—Prof. Ronald S. Edwards: "Industrial Technologists and the Social Sciences". (Inaugural Lecture.)*

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Sir John Hacking: Inaugural Address as President.

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Dr. E. G. Richardson: "Acoustics in relation to Radio Engineering". (Members of the Acoustics Group of the Physical Society are invited.)

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (at Whitworth Art Gallery, Manchester), at 7.30 p.m.—Dr. H. A. Thomas: "Development and Design with Man-made Fibres".

Friday, October 12

ASSOCIATION OF APPLIED BIOLOGISTS (at the Royal Entomological Society of London, 41 Queen's Gate, London, S.W.7), at 11 a.m.—"Insect Physiology in relation to Applied Biology".

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION, (at the Grand Hotel, Aytoun Street, Manchester), at 2.30 p.m.—Discussion on "The Report of the Light Fastness Committee of O.C.C.A." (to be opened by Dr. J. G. Gillan and Mr. F. A. Walker).

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

ROYAL INSTITUTE OF PHILOSOPHY (at University Hall, 14 Gordon Square, London, W.C.1), at 5.15 p.m.—Sir Henry Cohen: "The Status of Brain in the Concept of Mind" (Manson Lecture).*

Saturday, October 13

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. J. W. Jones: "The Spawning of the Atlantic Salmon".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER (with a degree in pharmacy, physiology, pharmacology or medicine) IN THE DEPARTMENT OF PHARMACOLOGY—The Secretary, School of Pharmacy, 17 Bloomsbury Square, London, W.C.1 (October 13).

ASSISTANT PHYSICIST (with an honours degree in physics or allied subject) in the Physics Department—The Clerk to the Governors, St. Bartholomew's Hospital, London, E.C.1, endorsed 'Physicist' (October 13).

RESEARCH ASSISTANTS with electrical engineering knowledge (to at least Higher National Certificate standard) and experience of, or aptitude for, training in measurements in the field—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds (October 13).

SCIENTIST, Grade III (with an honours degree in either geology or botany) IN THE COAL SURVEY LABORATORY, Sheffield, for work on the palæobotany of coal and the correlation of seams—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/374 (October 13).

SCIENTISTS, Grade III (with a good honours degree in chemistry; experience in analytical technique desirable) in the Laboratories at Chester and Newcastle-upon-Tyne—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/376 (October 13).

TECHNICAL OFFICER II (temporary, with a good honours degree in geography or geology) for work in the employment service of the Technical and Scientific Register, dealing mainly with graduates in geography, geology and psychology—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.335/51 (October 13).

GRADUATE CHEMIST (with biochemical training or interest) to assist in a programme of research on nucleoproteins and allied problems—The House Governor, Royal Cancer Hospital, Fulham Road, London, S.W.3 (October 15).

LECTURER IN GLASSHOUSE AND FLOWER CROPS, and an ASSISTANT LECTURER IN MACHINERY—The Principal, Kent Horticultural Institute, Swanley, Kent (October 15).

RESEARCH FELLOW TO WORK IN THE DEPARTMENT OF METALLURGY on theoretical problems concerning the structure and properties of metals—The Secretary, The University, Edmund Street, Birmingham 3 (October 15).

VICE-CHANCELLOR OF THE UNIVERSITY OF NEW ZEALAND—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 15).

AERONAUTICAL AND MECHANICAL ENGINEERS (Experimental Officer grade) mainly in the aerodynamics and structures departments at the Royal Aircraft Establishment, South Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.572/51A (October 20).

ASSISTANT EXPERIMENTAL OFFICERS to train in London as weather forecasters, for services mainly at airfields in the United Kingdom—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.26./51A (October 20).

CHEMICAL ENGINEERS (Principal Scientific Officer grade), with a first- or second-class honours degree in chemical engineering, at a Ministry of Supply research and development establishment, initially in North-West England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.651/51A (October 20).

CHEMIST (male) for the post of War Department Analyst (Food Supplies), to take charge of the chemical laboratory at the Army Supply Depot, Singapore—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.657/51A (October 20).

CONSULTANT to take charge of and develop a consultant service to advise commercial and industrial concerns, learned societies, etc., on the establishment and efficient conduct of technical information services and specialized libraries—The Director, Aslib, 4 Palace Gate, London, W.8 (October 20).

ELECTRICAL AND MECHANICAL ENGINEER in the Public Works Department under the Government of Cyrenaica—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.429/51–O.A. (October 20).

LECTURER IN SURVEYING IN THE MINING DEPARTMENT—The Registrar, The University, Leeds 2 (October 20).

MATHEMATICIANS at a Ministry of Supply research and development establishment in the South-East of London: SENIOR EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER to take charge of, organize and build up a small computing section, and an EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER, with interest in applied mathematics or numerical analysis—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.254/51A (October 20).

RESEARCH ASSISTANT (with a good honours degree in physics or physical chemistry) for work on the physical and chemical aspects of selective flotation—The Registrar, The University, Leeds 2 (October 20).

SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in engineering, hydro (or aero) dynamics and/or in physics, or an equivalent qualification) at the Marine Laboratory, Aberdeen, to work in conjunction with the fisheries biologists in studying the effects of modifications of commercial fishing gear and in devising new types or modifications of gear to increase fishing efficiency—The Establishment Officer, Scottish Home Department, Room 364, St. Andrew's House, Edinburgh 1 (October 20).

RESEARCH OFFICER (biochemist) IN THE DIVISION OF FOOD PRESERVATION AND TRANSPORT, Commonwealth Scientific and Industrial Research Organization, to conduct investigations on the biochemistry of muscle, initially with particular reference to the problem of labile

sulphur—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3579 (October 27).

CHEMIST, Government Metallurgical Laboratory—The Secretary, Southern Rhodesia Government, Rhodesia House, 429 Strand, London, W.C.2 (October 31).

LECTURER IN THE DEPARTMENT OF ECONOMICS at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

PHYSIOLOGIST (with honours degree in physiology or honours degree in zoology or biochemistry, with physiology as subsidiary subject) for studies in the general field of the environmental physiology of animals in hot environments, and an EXPERIMENTAL PHYSICIST (with honours degree in physics or equivalent) for work concerned with the instrumentational and biophysical aspects of heat exchange in animals—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (October 31).

PRINCIPAL SCIENTIFIC OFFICERS IN THE MECHANICAL ENGINEERING RESEARCH ORGANIZATION of the Department of Scientific and Industrial Research: ENGINEER (with experience of research on engineering materials, preferably on the creep and fatigue resistance of metals at high temperatures) for research into the properties of engineering materials at high temperatures, and an ENGINEER (with experience of the application of research in industry) to lead research into generic problems of mechanical engineering in the Division studying lubrication, wear, and the mechanical engineering aspects of corrosion, on such problems as the lubrication of high-speed bearings, reciprocating mechanisms, gears, etc.—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4079/51 (November 8).

PRINCIPAL SCIENTIFIC OFFICERS in the Royal Naval Scientific Service: PHYSICIST (with considerable experience in the development of electronic amplifiers and similar devices, together with a wide experience of magnetic and electromagnetic apparatus and a thorough knowledge of eddy current phenomena in various conducting media) to lead a group of scientists engaged on the development of electric and electromagnetic devices, at the Underwater Countermeasures and Weapons Establishment, Havant; a PHYSICIST able to take charge of a division carrying out applied research in connexion with underwater explosives, gun and rocket blast, and the effect of these on ships' structures, and an ENGINEER familiar with modern techniques of and theory of structures, to undertake both small and large-scale load strain measurements, and with a sound knowledge of the design investigations and experiments involving the mechanical testing of structural assemblies in steel, at the Naval Construction Research Establishment, Rosyth—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4080/51 (November 8).

SENIOR LECTURERS IN MECHANICAL ENGINEERING (Thermodynamics and Heat Engines): (*a*) Internal Combustion Engines and Gas Turbines, (*b*) Steam and Refrigeration, at the New South Wales University of Technology—The Agent General for New South Wales, 56–57 Strand, London, W.C.2, stating post applied for (November 12).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics or engineering, or corporate membership of one of the professional institutions, or able to produce evidence of outstanding qualifications and experience; sound knowledge of the radio valve industry in this country, including manufacturing techniques and the development of commercial radio valves is essential) IN THE ROYAL NAVAL SCIENTIFIC SERVICE for temporary assignment to the staff of the British Joint Services Mission, Washington, U.S.A.—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4078/51 (November 15).

PROFESSOR OF PHILOSOPHY, and a LECTURER (Grade I) or SENIOR LECTURER IN MATHEMATICS, at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 15).

SENIOR LECTURER IN GEOGRAPHY at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 15).

DIRECTOR of the Central Building Research Institute, Roorkee, Uttar Pradesh, India—The High Commissioner of India, General Department, India House, Aldwych, London, W.C.2, quoting No. 474.A (November 17).

LECTURERS (2) IN BIOCHEMISTRY at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 17).

CHAIR OF SOCIAL STUDIES in the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 30).

SENIOR RESEARCH OFFICER IN CHARGE OF THE MICROBIOLOGICAL CHEMISTRY SECTION of the National Chemical Research Laboratory in Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, December 1).

ASSISTANT LECTURER (experienced social worker with university qualifications) IN THE DEPARTMENT OF SOCIOLOGY, SOCIAL STUDIES AND ECONOMICS—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1.

ASSISTANT LECTURER (Grade B) IN THE DEPARTMENT OF MATHEMATICS—The Principal, Sir John Cass College, Jewry Street, London, E.C.3.

ASSISTANT LECTURER, Grade B (with a good honours degree in physics or electrical engineering; some industrial or teaching experience in electronics is essential) FOR APPLIED PHYSICS, at the College of Technology and Commerce—The Director of Education, City Hall, Cardiff.

CHEMIST II/ENGINEER II in the Ministry of Supply, London, for the supply and planning of either ferrous or non-ferrous metals used in the manufacture of aircraft, engines and associated equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.674/51A.

CHEMISTS (Principal Scientific Officer grade), with a first- or second-class honours degree or equivalent in chemistry, with many years responsible research experience in modern methods of analysis of inorganic materials, including microchemical methods, at a Ministry of Supply research and development establishment near London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.640/51A.

CHEMISTS (Principal Scientific Officer grade), with a first- or second-class honours degree in chemistry, or equivalent qualification, with experience in the field of combustion research, at a Ministry of Supply research and development establishment in Buckinghamshire, for work on problems of combustion in solid and liquid propellant rocket motors—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.650/51A.

CHEMISTS II and III in the Ministry of Supply, London, for the investigation of requirements for non-metallic materials used in the manufacture of aircraft, engines and equipment, and the assessment and planning of manufacturing capacity for these materials—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.675/51A.

CHIEF HYDROLOGICAL ENGINEER, and HYDROLOGICAL ENGINEERS (4), in the Soil Conservation Section of the Ministry of Agriculture, Sudan Government—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Chief Hydrological Engineer 4/404' or 'Hydrological Engineer 4/404'.

DEPARTMENTAL ASSISTANT IN POULTRY HUSBANDRY at the School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham.

ELECTRICAL ENGINEERS (Experimental Officer grade) at the Royal Aircraft Establishment, South Farnborough, for work on aircraft electrical generating equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.425/51A.

FIELD OFFICERS (2) IN A TSETSE SURVEY AND RECLAMATION team working in the Southern Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Veterinary Field Officer, 4/2202'.

FIELD ZOOLOGIST, Kenya (Ref. 27066/12), to undertake survey work of tsetse distribution, to make ecological studies of tsetse control, etc., a PROVINCIAL TSETSE OFFICER, Tanganyika (Ref. 27059/74), to carry out tsetse surveys and inaugurate all anti-tsetse measures in the province, a PUBLIC ANALYST, Northern Rhodesia (Ref. 27106/53/51), to perform the normal duties of a Public Analyst, including toxicology, and a CHEMIST in Tanganyika (Ref. 27106/35/51), for general analytical work of a development research nature, particularly in connexion with agriculture, etc.—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting the appropriate Ref. No.

JUNIOR INVESTIGATOR (with B.Sc. or equivalent in metallurgy) for work on the physical metallurgy of mild steel weld metal—The Secretary, British Welding Research Association, 29 Park Crescent, London, W.1.

LECTURER IN GEOLOGY, and an ASSISTANT LECTURER IN PHARMACOGNOSY—The Registrar, The University, Nottingham.

METEOROLOGICAL ASSISTANTS for service in the Antarctic with the Falkland Islands Dependencies Survey—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.27576/E.

METEOROLOGICAL OFFICERS (women, with honours degree in mathematics, physics or geography), for special Short Service Commissions—The Director, Women's Royal Naval Service, Admiralty, Whitehall, London, S.W.1.

MICROANALYST to take charge of the Microanalytical Department—The Chairman of the Scientific Committee, Weizmann Institute of Science, Rehovoth, Israel.

PHYSICIST to supervise research work connected with the mechanical properties of metals and alloys, including creep, fatigue, corrosion fatigue and stress corrosion, and to be responsible for the interpretation of results according to modern physical conceptions—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

RESEARCH OFFICER (Ref. A.31) (with university degree in chemical engineering or physics) for work on problems in connexion with solid fuel fired gas turbines, and an EXPERIMENTAL ASSISTANT (Ref. A.18) for work in connexion with the instrumentation of experimental coal burning equipment, and RESEARCH OFFICERS (Ref. A.35) (male or female, with degree in physics or equivalent) to work on problems in connexion with the use of fuel in domestic appliances with particular reference to smoke elimination—The Assistant Secretary, British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey, quoting the appropriate Ref. No.

RESEARCH OFFICER (biochemist) for service in Kenya, Tanganyika and Uganda, to be responsible, under direction of medical staff, for chemical work in connexion with testing new drugs on humans, and to assist in dietary surveys—The Under-Secretary of State, Research Department, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

SCIENTIFIC ASSISTANT (Analyst) by the East Africa High Commission for the East African Agriculture and Forestry Research Organization—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.27761.G.

SCIENTIFIC OFFICER (Chemist) AT THE WATER POLLUTION RESEARCH LABORATORY (Department of Scientific and Industrial Research), Minworth, Birmingham, for work on the effect of temperature on rate of oxidation of organic matter by bacterial action—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.323/50A.

STATISTICAL OFFICER (who will be responsible for the planning of statistical surveys and returns, and for statistical analysis) in the Government Statisticians Department, Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27297/1/51.

SURVEYOR (Ref. 27076/23) to carry out special duties in charge of levelling in Kenya, and ASSISTANT SURVEYORS (Ref. 27076/28/51) in the Federation of Malaya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting the appropriate Ref. No.